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MEMOIRS
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GEOLOGICAL SURVEY OF INDIA.

Palaeontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

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Ser. XIII. SALT-RANGE FOSSILS,

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I. PRODUCTUS-LIMESTONE FOSSILS:

iv. (fas. 1.) BRACHIOPODA.

WITH PLATES XXV—XXVIII.

CALCUTTA:

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Province : **MOLLUSCOFA.**

Class : **BRACHIOPODA.**

Order : **ARTHIROPOMATA**

Family : ***TEREBRATULID.E.***

The *Brachiopoda* are the most numerous among all the fossils occurring in the Productus-limestone of the Salt-range, and the materials of this class in my hands are so extensive, that it will be possible to add several new observations to the stock of knowledge already in our possession regarding these fossils.

It is however a matter of much controversy in what manner such observations ought to find expression, whether they should take form by the creation of new genera and species, or whether they should merely be used to illustrate the relations between different groups of the class as now imagined.

It cannot be denied, that in the systematic arrangement of the Mollusca in general, there has in recent times prevailed a tendency to restrict the large generic groups, resolving them into a number of smaller and more sharply defined genera, which should at the same time serve to bring out more clearly the changes the Molluscs have undergone in time, so as to unite under one generic heading those forms which are not very far separated from each other in time. This tendency had its beginning with the American paleontologists, whilst the sharper distinction of genera amongst the recent Mollusca was inaugurated by the brothers Adams.

There is no obvious reason why the *Brachiopoda* should be excluded from the tendency now prevailing among men of science in relation to the Mollusca proper, the less so as the shells of *Brachiopoda* require even sharper distinction than do the shells of Mollusca. Any one who has ever had to determine the shells of *Brachiopoda* must know, that in certain groups, for instance, in the group of the *biplicate Terebratula*, it is nearly impossible to determine a species without knowing the formation from which the specimens came, and even if this latter fact be known, it requires the utmost carefulness and the observation of the most minute characters to distinguish the different species and arrive at a satisfactory specific determination of these shells.

A most striking instance of the difficulties that surround the determination of such shells is furnished by a species that occurs in the Salt-range, and which has been described by Mr T. Davidson as *Terebratula biplicata*, Brocchi, var. *problematica*. This shell exhibits in a very striking manner the external characters

of *biplicate Terebratulæ*, and, led by these external characters, Mr. Davidson suggested that this species came from mesozoic (probably cretaceous) strata, and that thus also this formation was apparently represented in the Salt-range. As a matter of fact the shell comes from the Productus-limestone, and has nothing whatever to do with *Terebratulæ biplicata*, Brocchi. To make out this fact it was only necessary to investigate the internal structure of the shell. All the European palæozoic *Terebratulæ* have an internal structure which deviates by certain very constant peculiarities from the structure of the mesozoic shells. Just the same peculiarities which characterise the European palæozoic *Terebratulæ* are also exhibited by the Indian species, and thus it becomes evident that this shell also is of palæozoic age. Now it is not likely that any one in the world would pretend that he knows the *Brachiopoda* more thoroughly than the celebrated palæontologist of Brighton, yet even he has been misled by the external form. Had a more minute generic grouping existed at the time of the description of this shell, and had it been unavoidable to ascertain at least some of the internal characters of such a shell in order to effect an exact generic determination, such a mistake would have been impossible, as the author would immediately have known that he had to deal with a palæozoic species.

By such occurrences it is strikingly demonstrated how useful the distinction of more limited generic groups in reality is; so it must be considered as a most meritorious undertaking on the part of M. Bayle, as well as by M. Douvillé, to split up the old genus *Terebratula* into several new generic groups, or at least to advocate the retention of the generic groups already created by King and others, but which had been considered until very recently as simple synonyms of *Terebratula*.

Douvillé's remarkable paper starts from the consideration of the mode of development of the internal appendages in the shells of recent *Terebratulidæ*, and comes to the conclusion that, according to this development, two large divisions should be distinguished, one comprising the forms with a long loop, to which should be added those forms like *Terebratella* or *Megerlea*, in which the loop is doubly or trebly joined to the valve; and another division comprising the shells with a short loop. The author wishes to consider the two groups as separate families for which he introduces the names of "*Waldheimulæ*" and "*Terebratulidæ*." I do not think it practicable thus to destroy the old family *Terebratulidæ*, which seems to be so well founded, and has been so excellently defined. It will be quite sufficient for the purpose of bringing out the significance of these groups to consider them as subfamilies, for which I wish to introduce respectively the names of "*Terebratulinae*" and "*Waldheimulinae*."

If however subfamilies are once introduced, the other genera which cannot be comprised in the two preceding subfamilies must also be brought under similar headings. There is not much that I can suggest in this direction. A limited group seems to be indicated by some forms, of which *Centronella*, Billings,

might be taken as the type. They have no cardinal process in the smaller valve; the loop is of medium size, very simple, and without recurring branches, but it seems not to be sufficiently known in all the forms apparently belonging to the group. These forms might nevertheless be conveniently united in a subfamily bearing the name of *Centronellinae*. The subfamily is also represented in the Salt-range. A fourth subfamily might be formed by the genera *Megauteris*, Suess, and *Rensseleria*, Hall, but I cannot say anything positive on this point.

The geological distribution of the different subfamilies thus established is very different. The oldest are apparently the *Waldheimiinae*, which seem to include the oldest forms of all the *Terebratulidae*. The form to which I allude is *Terebratula melonica*, Barr., from upper silurian strata of Bohemia. The general arrangement of the internal appendages in the smaller valve seems, according to M. Hall's figures,¹ not quite dissimilar to that prevailing in *Mucandrewia*, King. In the larger (ventral) valve there are two very long dental plates, whilst in the smaller or dorsal valve the sockets for the reception of the teeth of the other valve are supported by two plates extending in an oblique direction from the bottom of the valve up to the sockets, and for which I shall introduce the name of septal plates, as, if their direction is very oblique, they unite in the middle and form together a distinct septum. These plates are of great importance for the classification of the *Terebratulidae* in general. The loop is long, reaching more than halfway down to near the front of the shell. It possesses two long recurring branches, which unite by a slender transverse piece. The peculiar feature that seems essentially to distinguish this loop from that of *Mucandrewia* is the position of the spurs which support the oral opening of the animal so very far from the apex of the shell. According to Douville's method this form should probably receive a proper generic designation, and might perhaps belong to the genus *Cryptonella*, Hall, but the transverse band on the crura uniting them near their origin on the dorsal side has not yet been observed. Be this as it may, there is no doubt that the subfamily *Waldheimiinae* was already represented during the upper silurian period, after the detection by Mr. Davidson of two species, which he described under the names of *Waldheimia mawee* and *W. glassii* from the soft Wenlock shales. Though these species be very minute, and Mr. Davidson may prefer to quote them only with a query under the heading of *Waldheimia*, yet the drawing of the loop represents so undoubtedly a form belonging to the subfamily, the external shape of the shell recalling already the general form of *Antiplychninor* and *Antacothyrus*, that the representation of the subfamily in upper silurian strata can barely be doubted. In the carboniferous formation also, a species has been detected which undoubtedly agrees in all its characters with the typical species of the *Waldheimiinae*. This shell occurs in the carboniferous deposits on the Rio Tapajoo in Brazil, and has been described by Mr. O. A. Derby under the name of *Waldheimia contonhoana*. The loop which he figures leaves

¹ Hall's 16th Report of the New York State Museum, 1863, reproduced in Barrand's *Systema Silurum de Bohemia*, vol. V, pl. 131.

no doubt as to its family relations, and the species might with great probability be attributed to the genus *Zeilleria* of Bayle. *Terebrat. bovidens*, Mort., is also said to possess a long apophysary system, but this has not been figured up to the present.

In the older palæozoic epochs, together with the typical forms just mentioned, there occur in somewhat greater numbers some forms of shells which also belong very likely to the subfamily *Waldheimiinae*, but which have been distinguished by Hall under the name of *CRYPTONELLA*, Hall (1861, fourteenth Report of the New York State Museum, p. 21; Pal., New Y., Vol IV, p. 392, pl. LXI) This genus is characterized by a very long loop with long recurring branches. The crura near their origin on their dorsal side are united by a transverse shelly band. Of the characters of the hingeplate nothing is known; there seems to be no septum. In the ventral valve dental plates seem to be present. So far as is now known the genus is restricted to the silurian and devonian periods.

From the trias upward, the *Waldheimiinae* begin to get numerous; but it is only in jurassic times that they begin to be split up into a number of different genera. Of these the following may be mentioned.—

PLESIOTHYRIS, Douv. (Bull. Soc. Géol. de France, 3 ser., Vol. VII, p. 275, 1879) dental plates in the ventral, and a septum in the dorsal valve, loop long, free, general form biphiculate.

ZEILLERIA, Bayle (Expl. Carte Géol. de France, Vol IV, Atlas pl. IX, 1878). dental plates in the ventral, and septum in the dorsal, valve, loop long, free, general form with a straight frontal line

AULACOTHYRIS, Douv. (Bull. Soc. Géol. de France, 3 ser., Vol. VII, p. 277, 1879) ventral valve emarginate, with dental plates, dorsal valve sinuate, with a septum, loop long, free.

ANTIPTYCHINA, Zittel (Handb. d. Palæont., p. 704, 1880) ventral valve with dental plates and two strong folds in the frontal part, dorsal valve with a septum, a sinus in the frontal region with a fold in the middle, loop very long, free

EUDESIA, King (Peim. Foss., p. 114, 1850) internal arrangement as in *Zeilleria*, shell strongly plicated.

TREBRATELLA, Orb. (Pal. Fr. Ter. Cét., Vol IV, p. 110, 1847) loop long, but not free, affixed to the cardinal plate as well as to the septum

MYGGERLEA, King (Peim. Foss., p. 81, 1850) loop tightly attached.

Of these genera only one is restricted to the jurassic period, viz., *Eudesia*, King; all the others extend also into cretaceous strata. Here, however, a number of new genera is added. Of these may be mentioned—

LYKA, Cumberl. (Sow. Min. Conch., pl. 138, f. 4-6, 1816).

TRIGONOSEMUS, Koenig (Icones Foss. Scetil., p. 3, pl. IV., f. 73, 1825)

KINGENA, Davidson (Mon. Brit. Cret. Brach., p. 42, pl. IV., f. 15-28, 1852)

MAGAS, Sow (Min. Conch. II., p. 39, pl. 119, f. 1-5, 1816)

RHYNCHORA, Palm. (Kongl. Vet. Acad. Handl., 1827, p. 10.),

which are all sufficiently well known so that their diagnosis need not be repeated here

In the actual period MACANDREWIA, King; NEOTHYRIS, Douv.; and WALDHEIMIA, King, further augment the number of genera, not to speak of MAGASELLA, Dall; FRENTULA, Dall, etc.

One strange fact, however, cannot be passed in silence, that the appearance in time of the genera belonging to the subfamily *Waldheimiinae* is very little in accordance with what one might expect according to the laws of development.

The individual development of the recent *Waldheimiinae* has been studied by Eriole, Dall, etc., and it has been found that the internal apparatus of the recent species undergoes a number of changes before it attains the shape and arrangement of the adult specimens. The first stage that has been observed is an arrangement of the loop, very similar to that occurring in adult specimens of the genus *Magas*. In the further development of the specimens of *Waldheimiinae* the very large septum is partly re-absorbed, and then appears a stage which is most similar in its loop to that existing in adult specimens of *Terebratulina*; and only after a further partial absorption of the septum, and other changes in the loop, does the permanent shape of the loop of *Waldheimiinae* appear, and the specimen is at last full grown. If now the development of the individual only repeats the development the whole family has taken, we should expect to find that the geologically oldest representatives of the subfamily should exhibit a loop similar to that of *Magas*, and that the long and free loop of *Waldheimia* ought to appear only in later geological periods. But just the reverse is the case. The geologically oldest representative, *Terebr. melouca*, Barr, has a long, free loop; and even if this species should prove to belong to the genus *Cryptonella*, this would not materially alter the fact. Even if we exclude the genus *Cryptonella* from the discussion, yet we find already in the upper silurian period (the Wenlock shales), a shell which in all important characters agrees with the jurassic *Antiphragma* or *Autacothyrus*, having a well developed, long and entirely free loop. The first species of *Terebratulina* have up to the present been observed to occur in jurassic strata, whilst *Magas* does not occur earlier than in the cretaceous period. The mode of development the single individuals of the recent *Waldheimia* undergo is thus rather to be termed a retrograde than a progressive one.

The subfamily *Terebratulinae* was already well developed in the devonian period, though forms belonging to it were not very numerous. Some of these devonian species seem to belong already to the genus *Diclasma* of King, whilst others seem to form part of a new genus, which has also many representatives in the Salt-range. The subfamily has been considered up to very recent times as being composed only of two genera, viz., *Terebratulina* (*Diclasma*, King, having been considered as synonymous) and *Terebratulina*. It has been shown by Douvillé not only that the genus *Terebratulina* was in a more close relation to *Terebratula* than to any other genus, the two thus forming one family (or subfamily), but also that the enormously large number of forms included in the old genus *Terebratula* could very conveniently be subdivided into a number of generic groups.

Douvillé finds his classification partly on the external form of the shells, partly on the presence of dental plates or of a septum; but to him the fact was not yet known that in the *Terebratulinae* the septum is only produced by the junction of the two septal plates, and that it is a mere matter of degree whether the septal plates are so oblique in their direction as to join and form a septum, or whether they are less oblique and meet the bottom of the valve before reaching the middle of it. This latter fact has been clearly brought to light by the very careful investigations of the rhætic *Brachiopoda* and their allies by M. Zugmeyer. Therefore not only the septum but also the existence of septal plates is a factor of great importance in the classification of the *Terebratulinae*.

If we apply these principles of classification to the mass of shells which have hitherto been considered to belong to the genus *Terebratula*, we come to the following generic subdivisions:—

TEREBRATULINA, Orb. (Ann. Sc. Nat. VIII, p. 249, 1847) : shell finely striated radially; loops short, free, forming a closed circle. jurassic to recent.

TEREBRATULA, Klein (Tentamen methodi ostracologicæ, p. 171, pl. XI, nr 74, 1753) : shell biplicate; loop short, free, not annular, without septal plates; no dental plates in the ventral valve. *Liothyris*, Douv., can barely be considered but as a subgenus of *Terebratula*, since young specimens of *Terebratula*, as has been rightly remarked by Zittel, would very often have to be considered as *Liothyris*, whilst the adult forms would be *Terebratula*: (? devonian) triassic to recent.

RHÆTINA, Waagen, n. gen.: shell biplicate; loop short, fixed to the bottom of the valve by septal plates, which sometimes form a septum, sometimes not; ventral valve without dental plates. Type: *Terebratula gregaria*, Schafh. from rhætic beds: rhætic.

DIETASMA, King (Nat. Hist. Rev., Vol VI, p. 519, 1859) = *Epithyris*, King (non Phillips): shell biplicate or simply vaulted on the frontal line; loop short, fixed to the bottom of the dorsal valve by septal plates, which form sometimes a distinct septum (see Davidson Monogr. Perm. fossils, pl. I, figs 18-20); very strong dental plates in the ventral valve: devonian to trias.

ZUGMYLERIA, Waagen, n. gen.: shell biplicate; loop short, without septal plates; strong dental plates in the ventral valve. Type, *Terebrat. rhætica*, Zugm. rhætic.

COENOTHYRIS, Douvillé (Bull. Soc. Géol. de France, 3rd ser., Vol. VII, p. 281, 1879): shell with a vaulted frontal line; loop short, fixed to the bottom of the dorsal valve by strong septal plates, which mostly unite to form a strong and tolerably long septum; transverse part of the loop, uniting the recurving branches, forms a flat shield; in the ventral valve dental plates are developed in young specimens, which are however re-absorbed in adult ones: muschelkalk.

PRYGONE, Lunk. (Handb. Phys. Erdbesch., Vol II, part 1, p. 451, 1830): dorsal valve with a mesial impression, ventral valve with a fold; the mesial part, occupied by the sinus in the dorsal valve, often stops in growth, whilst the lateral parts continue augmenting in size, thus forming a perforation in the shell; the loop

is very small and free; neither septal nor dental plates exist. It seems to me perfectly reasonable in Zittel to unite Douvillé's genus *Glossothyris* with *Pygope*, as the distinction between the two genera seems to be only a matter of degree: jurassic and lowest cretaceous

DICTYOTHYRIS, Douvillé (Bull. Soc. Géol. de France, 3rd ser., Vol. VII, p. 268, 1879): plication of the valves the reverse of that occurring in the *Biplicate*; the dorsal valve with two impressions, and the ventral one with two folds; loop short and free; neither septal nor dental plates; surface of the shell mostly finely striated radially. jurassic and lower cretaceous.

HEMIPTYCHINA, Waagen, n. gen. surface of the shell smooth, or irregularly folded in the frontal region; frontal line vaulted; loop short like in *Terebratulina*, with distinct septal plates, which very rarely unite to form a septum. Type, *Terebratulina himalayensis*, Davids. It seems that the jurassic forms (as *Ter. plicata*, Buckm., *T. fimbria*, Sow., etc.) resembling *Hemiptychina* are distinct from the palaeozoic shells by the absence of septal plates; they would then very likely have to be considered as forming a distinct genus.

DIELASMINA, Waagen, n. gen. shell strongly but irregularly folded radially, internal arrangement as in *Dielasma*. Type *Diel. plicata*, W. n. sp.

It may perhaps be desirable to bring the above-mentioned genera into a tabular arrangement, similar to that given in Douvillé's paper in the Bull. Soc. Géol. de France, 3rd ser., Vol. VII, p. 263. They would then have to be arranged in the following manner:

Annular—by the union of the oral processes Neither dental nor septal plates	NOT ANNULAR—BY THE DIVISION OF THE ORAL PROCESSES				
	Neither dental nor septal plates	Only dental but no septal plates	Only septal but no dental plates	Septal and dental plates	
<i>Terebratulina</i> , Orb	<i>Terebratulina</i> , Klin	<i>Zenopsis</i> , Waagen	<i>Rhynchonella</i> , Waagen	<i>Dielasma</i> , King <i>Glossothyris</i> , Douv	<i>Biplicate</i>
	(Nov. gen.?)		<i>Hemiptychina</i> , Waagen	<i>Dielasmina</i> , Waagen	<i>Fimbriata</i>
	<i>Pygope</i> , Link				<i>Denticulata</i>
	<i>Dictyothyris</i> , Douv				<i>Concavata</i>

By far the greatest number of forms belonging to the family *Terebratulidae* is included in the two subfamilies treated of on the foregoing pages, there are however yet remaining a small number of generic groups which do not fit into these two subfamilies, and which in part at least can be considered as forming distinct subfamilies. Already above I have shortly hinted that yet two more subfamilies

¹ I use the name of "*Fimbriata*" for those forms which never are truly biplicate, but smooth in the young state and more or less strongly and irregularly plicated when adult. Example *Terebratulina fimbria* Sow.

may be distinguished, which may respectively be termed "*Centronellinae*" and "*Meganterinae*." Within these two subfamilies all the remaining genera of *Terebratulida* (except quite doubtful ones like *Vipulina*, Hall, *Leptocælia*, Hall, etc.) can be brought. Only for one genus does the systematic position remain doubtful; this is *Hynniphoria*, Succs.

There is a genus of *Terebratulida* in the Salt-range for which I propose to introduce the name of *Notothyris*. It is very difficult to assign a place in the system for this genus, as its internal arrangement is not yet entirely known. The most characteristic feature of its internal appendages is that the hingeplate in the dorsal valve bears a distinct oval foramen in the umbonal region. The loop seems not to have been complete. On the whole it seems not improbable that these shells are more or less nearly related to *Centronella*, and I thus shall put this genus into the subfamily *Centronellinae*.

Subfamily: *Terebratulinae*.

Genus: *Dielasma*, King.

There are not many writers up to the present who would have accepted this genus as well founded and would have kept it entirely apart from *Terebratula*. It cannot be denied that its affinity to *Terebratula* is very great; but if we observe how very constant the characters are by which it can be distinguished from the true *Terebratula*, and how the occurrence of these characters is limited to certain formations, it must be admitted that the distinction of the genus is of great, practical value and of the utmost importance at least to the geologist, who finds in the dental and septal plates of such indifferent forms as the *biplicate Terebratula* a most convenient clue for the determination of the geological age of the beds containing such fossils.

The characters of *Dielasma* are very easy to be recognised. They consist in the general terebratuloid form of the shell; a short loop like in *Terebratula*, fastened near its origin to the bottom of the smaller or dorsal valve by two plates, which extend in a more or less oblique direction from the sockets for the reception of the cardinal teeth towards the middle line of the dorsal valve, forming sometimes a septum. The umbo of the smaller valve bears a distinct cardinal process. In the larger or ventral valve the cardinal teeth are supported by very strong dental plates. The existence of these dental plates as well as of the septal ones can easily be made out by scraping off a little of the shell on the beak as well as in the umbonal region of the smaller valve; the plates will then soon appear as dark lines, converging towards the termination of the beak as well as towards the apex of the smaller valve.

The genus was already distinguished by King in the year 1850, but at that time the author thought it possible to utilise the old name of *Epithyris* (given by Phillips to all the *Terebratulae*) for this particular group, and thus he introduced

the forms belonging to the genus under the name of "*Epithyris*, Phillips." The same view of the matter is also taken by Dall, who accepts the name *Epithyris* for these forms, but writes "*Epithyris*, King" not Phillips. Now, in reality, King never created a genus under the name of *Epithyris*; he only used Phillips' denomination in a wrong sense. It thus seems incorrect to apply the name of *Epithyris* to this group; as it cannot be admitted that a name should be used in science in a sense quite different from that attributed to it by the author who created it. It seems therefore that King was quite correct in creating a new name for the forms here under consideration, and in doing so he very likely acted upon the same considerations as have led me to adopt his name *Dielasma*.

M'Coy, in his "British Palaeozoic Fossils," thought proper to apply the name *Seminula*, which he had formerly given to other shells, to the species which form now the genus *Dielasma*; but, as in the original diagnosis of *Seminula* only those shells were comprised which belong to the families *Rhynchonellidae* and *Spisiferidae*, it does not seem advisable to transfer the name now to shells belonging to the *Terebratulidae*; thus, from this consideration also, the name *Dielasma* will have to stand.

The genus seems to commence in the devonian period, but it does not appear to have been very common then. *Terebrat. lincklaeni*, Hall, seems to belong to it, but otherwise many species do not seem to occur. The chief development of the genus is during carboniferous and permian times, in which till quite recently no other forms were known to exist. Already in the trias the genus seems to become again very scarce, and in the upper region of this system, the Kossen beds, it is entirely replaced by *Rhætna*, Waagen, and *Zugmeyeria*, Waagen; so that in these beds no traces of *Dielasma* are any longer found. Also in jurassic and cretaceous times the genus is entirely absent.

Among the forms of *Dielasma* occurring in Europe in carboniferous and permian strata, probably not less than six series may be distinguished, it seems however to be such a heresy to utter this opinion that I must dwell with some words more on the point. According to the views now greatly prevailing, all the shells which, in my opinion, may be grouped into six series, do not form more than one species. This species not only comprises all the carboniferous, but also the permian forms of *Terebratulide*, and has to be called *Terebrat. sacculus*, Martin. If we now review all the forms that come within the range of this name, we find that we have first the large forms, with a straight, not vaulted, frontal line, *Terebrat. hastata*, Sow., which would have to be counted among the 'Cinetar' of Leop. von Buch and Queenstedt. The same would occur with a small form with vaulted valves and a more or less emarginated front, the *Terebr. sacculus*, Mart., in a restricted sense, and perhaps *Terebr. sufflata*, Schloth. Then come the forms with a vaulted frontal line — *Terebr. ficus*, M'Coy; *Ter. burgoides* (M'Coy) Dav., *Terebr. sp.*, Dav., Mon. Brit. Perm. Brach., pl. 1, fig. 19; *Terebr. hastiformis*, Kon; *Terebr. plioa*, Kutorg; *Terebr. Gillingensis*, Dav., *Terebr. elongata*, Schloth, etc., which

would all have to be counted with the "*Biplicata*" of Leop. v. Buch and Quenstedt. Lastly there come the forms with a concave frontal line like *Terebrat. vesicularis*, Kon., which forms part of the "*Antiplicata*." All these forms now make up the one species *Terebrat. sacculus*, Mart. If now we find in any work the species *Ter. sacculus*, M., quoted as occurring in any particular bed, do we obtain by such a quotation the slightest idea what form really occurs? Or is it indeed quite irrelevant what form we have to deal with, or what form occurs just in that particular bed? Certainly not. The names which we apply to objects in nature have all been invented for the sole purpose of conveying to us concrete ideas of the objects themselves, but this point is absolutely lost, if we subsume such a number of forms to one name. A species of so monstrous an extension as is *Terebr. sacculus* (Mart.), Davidson, is absolutely useless for stratigraphical as well as for biological purposes; and if in every class of animals a similar extension were to be given to the species, we should soon have to renounce all the more exact stratigraphy and all our historical account of the development of the animal kingdom, resulting from an exact observation of the stratigraphy in connection with the minute distinction of the animal forms.

But there decidedly exist intermediate forms between all the above-mentioned species or sub-species, or whatever we like to call them; and a perfect transition can be traced from one form to the other. It cannot be doubted, and the standard of thorough study and excellent power of observation exhibited by all the works of Mr. Davidson is an absolute security for this, that the transitional forms really exist, and that all the fossils mentioned under the above names are all most intimately connected together; nevertheless, I must retain the opinion that these fossils have all to be considered as distinct species. Any one, who has collected Brachiopoda in large numbers in the field, will have made the observation that in this class of Molluscs, more than in other classes, transitional forms between different species occur, and that such transitional forms are chiefly numerous in certain groups, for instance in the biplicate *Terebratulæ*, more than in others. That such transitional forms occur between species which are of different geological age is only natural, and depends upon the mode of development of the species; but also between contemporaneous species transitional forms exist. In this latter case, the distribution of the transitional forms is very unequal; in some localities many of them occur, in others they are only very sparingly represented or even entirely absent. This mode of occurrence seems now to be in direct proportion to the number of specimens of each species which are found in each locality. In places where very great numbers of individuals of two species are heaped together, transitional forms are more numerous; in other localities, on the contrary, where two species occur, but not in great numbers, transitional forms are rare or even entirely absent. This seems to indicate a circumstance which has not up to the present been sufficiently taken heed of. In localities where two species in very great numbers were crowded, there seems to have been great possibility for the production of hybrids, whilst in

other localities where the two species were not so numerous few or no hybrids were produced, and thus in the cases of contemporaneous species the transitional forms might for the greater part be due to hybridity. But the production of hybrids cannot establish identity of species. It can thus, I think, very well be sustained that, even if transitional forms exist, yet two fossils of different shapes might very well form different species, and thus we come back to the old axiom that every form that can be fixed and distinguished from others by description and figures, has to be considered as constituting a species, though this must be understood "*cum grano salis*."

To return then to our starting point, I must repeat that the retention of more concise species can very well be sustained on biological grounds, and that it is an absolute necessity for the field-paleontologist ('paleontologue voyageur' as the French would say) to have more concise species, as he cannot speak for instance on the permian formation of *Terebr. sacculus*, because on the one hand forms exactly resembling the typical *sacculus* do not occur at all, on the other hand, because the form which really in great numbers do occur have not even the slightest resemblance to the typical *Terebr. sacculus*. Identical shapes may be picked out among a great number of specimens, as was done by Mr. Davidson, and that such specimens should occur is only natural, and can easily be explained by atavism, but the average form of the *Terebratulæ* occurring in each formation is perfectly sufficiently distinct to keep the two sets of shells separate as distinct species.

Starting from such considerations it seems to me that the more generally known European species occurring in the carboniferous and permian formations may be grouped in the following manner:—

- I.—Group of *DIELASMA HASTATUM*, Sow.
- II.—Group of *DIELASMA FLOUS*, (M'Coy), Dav.
 " *sp. nov.*, Dav, Mon. Brit. Perm. Brach, Pl. I, fig. 18.
- III.—Group of *DIELASMA SACCUUS*, Mart.
 " *SUFFLATUM*, Schloth.
- IV.—Group of *DIELASMA GILLINGENSE*, Dav.
 " *ELONGATUM*, Schloth.
- V.—Group of *DIELASMA VIRGOIDES*, (M'Coy). Dav.
- VI.—Group of *DIELASMA VESICULARE*, Kon.

By the true *Dielasma flous*, M'Coy, with its undulating frontal line, the existence of one more series might be indicated, but I cannot say anything positive about it. Of these series three pass up into the permian formation, whilst three others seem to be restricted to carboniferous strata.

In the Salt-range the genus *Dielasma* is rather largely represented, and the existence of several of the series of forms which have been just indicated as

distinguishable among the European species, can be recorded also in India. There are altogether ten species of *Dielasma* in the Productus-limestone of the Salt-range, which may be grouped in the following manner:—

- I.—Group of *DIELASMA SACCULUS*, Mart.
 1. *Dielasm. guttula*, W., n. sp.
- II.—Group of *DIELASMA GILLINGENÆ*, Dav.
 2. *Dielasm. elongatum*, Schloth. sp.
 3. „ *nummulus*, W., n. sp.
- III.—Group of *DIELASMA FICUS*, (M'Coy) Dav.
 4. *Dielasm. truncatum*, W, n. sp.
 5. „ *minor*, W, n. sp.
 6. „ *statubense*, Derby.
- IV.—Group of *DIELASMA BIPLIX*, W.
 7. *Dielasm. biplez*, W., n. sp.
 8. „ *breviplicatum*, W, n. sp.
 9. „ *acutangulum*, W, n. sp.¹
 10. „ *problematicum*, (Dav) W.

The last of these groups is one which is not represented in Europe, though it might stand in a certain relation to the group of *Dielasm. virgoides*, (M'Coy) Dav.

On the whole, the affinity of the species of *Dielasma* occurring in the Productus-limestone of the Salt-range is more with permian than with carboniferous species. Not only that one of the forms can be identified with the permian *Diel. elongatum*, Schl., but also *D. guttula* and *nummulus* can only be compared to *D. sufflatum*, Schloth. and *D. elongatum*, Schl., respectively; and even the whole group of *D. biplez* seems to be most intimately connected with *D. elongatum*. The form *D. acutangulum* so closely resembles elongated varieties of Schlotheim's species that I formerly did not think it quite improbable this shell may turn out to really belong to that species.

Of the other forms *D. truncatum*, W., is quite singular, and has not been observed anywhere else, whilst *D. Itatubense*, Derb., was originally described from beds in Brazil which, according to the other Brachiopods occurring in them, will have to be considered as being about on the same level as the upper coal-measures of North America.

I.—GROUP OF *DIELASMA SACCULUS*, Mart.

1. *DIELASMA GUTTULA*, Waagen, n. sp., Pl. XXVIII, fig. 14.

This very small species is about similar in size and form to a grape seed, inflated, rounded, with a small adpressed beak and a straight frontal line.

The ventral or larger valve is considerably more strongly inflated than the smaller one, and this holds good as well in the longitudinal as in the transverse direction. Posteriorly it is produced into a beak, which is in comparison to the

size of the shell rather thick, but not long, and bent distinctly over. It is pierced not quite at its extremity, but just posteriorly to it, by a tolerably large oval foramen. The beak is shut in below by a very indistinct false area, which can barely be called such, so much does it pass all round imperceptibly into the sides of the valve. The beak is so firmly adpressed to the apex of the smaller valve that it cannot be observed whether deltidial plates were present or not.

The smaller or dorsal valve is much flatter than the ventral one; it is, however, also very regularly vaulted. Both valves meet all round in a nearly perfectly straight line.

The surface of the shell is covered by numerous rather strong striae of growth. The punctuation of the shell cannot be very distinctly seen, as the shell is not very favourably preserved for the observation of this character. As far as it can be made out, the punctuation seems to have been rather coarse.

Of the internal characters nothing can be seen, even the existence of dental plates remains doubtful. The shell has been placed by me in the group of *Diel. sacculus* on account of the general similarity which it exhibited to the species belonging to that group.

The measurements of the only existing specimen are as follows:—

Entire length of the shell	. . . . .	6 mm
Length of the smaller valve	. . . . .	5 ..
Entire breadth of the shell	. . . . .	4.5 ..
„ thickness of the „	. . . . .	4 ..
Apical angle of the larger valve	. . . . .	62°

Locality and geological position.—The only specimen of this species was collected by myself at Amb at the very base of the compact limestones forming the middle division of the Productus-limestone.

Remarks.—This little shell may possibly be the fry of some other large form, and thus the propriety of its description as a distinct species may properly be doubted. It is however pretty certain that this shell is not the young of any of the species I shall have to describe, and thus it may pass as indicating the existence of a distinct species, of which the adult form may possibly yet be discovered. But this may just as well be a small species, of which the dimensions may never become much larger. This is a point which can only be cleared by further discoveries.

As far as can be judged from the little specimen available, it does not seem that this form is identical with any of the European species. The small specimens figured by Davidson, Mon. Brit. Carb. Brach., Pl. II, figs. 1, 2, have a much smaller and less stout beak, and it is almost beyond doubt that by the small specimen from the Salt-range a different species is indicated. There is a somewhat greater resemblance to young specimens of *Diel. sufflatum*, Schl. sp. as figured by Davidson, Mon. Brit. Perm. Brach., Pl I, figs. 11, 12, 13, but they differ in that the dorsal valve of the Indian specimen is much flatter than that of the specimens figured by

Davidson, and that the whole shell is covered by strong imbricating striæ of growth, which do not exist in the permian specimens. On the whole I feel justified in considering this shell as a distinct species, which is, however, most nearly related to *Diel. sufflatum*, Schloth.

II.—GROUP OF *DIELASMA GILLINGENSE*, Dav. sp.

2. *DIELASMA ELONGATUM*, Schloth, sp., Pl. XXV, fig. 10.

1816. *Terebr. elongata, et complanata*, Schloth. Denkschr. Acad. Munchen, Vol. VI, p. 27, pl. VII, figs. 7, 8, 9, 13, 14.
 1850. *Epithyrus elongata* (Schloth) King Monogr Perm Foss of England, p. 147, pl. VI, figs 30-45.
 1868. *Terebratula elongata* (Schloth) Davidson. Monogr. Brit. Perm. Brach., p. 9, pl. I, figs 5-7, 14, 19-22.
 1861. *Terebratula elongata* (Schloth) Geinitz. Jyas, p. 82, pl. XV, figs. 14-28.
 1870. *Terebratula elongata* (Schloth) Quenstedt. Petrefactenkunde Deutschlands. Brachiopt., p. 425, pl. 50, figs 104-116.

The general outline of this shell is slightly pentagonal, considerably longer than it is broad; the beak is small and adpressed, pierced just at its apex by a not very large, round foramen; the line in which the two valves meet is tolerably straight and only little vaulted in the frontal region.

The larger, or ventral, valve is a little more strongly inflated than the smaller one; its curve is very regular, the greatest thickness being a little below the middle of the length of the shell. Anteriorly it is slightly produced and bent up, forming the slightly vaulted frontal line. The beak is small and well bent over, limited on its lower side by an indistinct area, which is shut in on the upper side by indistinct ridges starting from below the foramen and extending to near the lateral parts of the valve. The beak is so firmly adpressed to the smaller valve that nothing can be seen of deltidial plates. The foramen is round and not large.

The smaller, or dorsal, valve is a little more flattened than the ventral one; nevertheless it is distinctly arched longitudinally, and in this respect resembles more that of *Dielasma sufflatum* than that of *D. elongatum*. The apex is pointed and slightly bent in.

The surface of the shell is smooth and only few striæ of growth are distinctly visible. The punctuation of the shell can only be observed in some places with the lens. It appears that the shell bears a kind of epidermis which covers up the punctuation, and only when this epidermis is removed can the punctuation be seen. It is very much like that of *Diel. elongatum* figured by King, very close and very fine.

Of the internal characters of this shell nothing can be seen, nor can they be made out for the present, as no large materials of this species are available. There is, however, but very little doubt that it bears the characters of the genus *Dielasma* in general, as in outward appearance it resembles so closely other species of the genus that an internal similarity may be expected.

The measurements of the figured specimen are as follows :—

Entire length of the shell	18 mm.
Length of the smaller valve	16 "
Entire breadth of the shell	14 "
" thickness " "	8.5 "
Apical angle of the larger valve, about	79°
" " " smaller valve	110°

Locality and geological position—There are altogether three specimens of this species preserved in the Salt-range collection : one collected by myself at Katta in the very lowest beds of the compact limestones forming the middle division of the Productus-limestone (bed Nr. 12 of my note-book) ; two others were also found by myself at Amb in a black, coaly sandstone forming the lowest fossiliferous bed of the lower division of the Productus-limestone at that locality.

Remarks.—The general form of this shell is rather similar to *Diel. sufflatum*, Schloth. sp., and resembles chiefly the variety figured by King on pl. VII, figs. 6, 9. Nevertheless I do not think that this shell should be considered identical with that species of Schlotheim, as several points of difference exist which make a distinction not only easy but even necessary. In the Indian shell the median depression, which extends from near the beak to the frontal region, corresponding to the bend in the frontal line is totally absent ; the valves are both less inflated, and the general form of the shell is altogether more elongated than in *Dielasm. sufflatum* ; but just by all these characters it agrees with *Diel. elongatum*. Of carboniferous species, *Diel. gillingense* must chiefly be compared ; but, after a careful examination of the figures, it seems directly impossible to unite the Indian shell with that carboniferous form. The highly characteristic flatness of the dorsal valve is absolutely wanting in the Indian shell, and, thus, the two forms cannot possibly be considered identical. On the other hand, if we compare the figures of *Diel. elongatum*, for instance that on Pl. VI, fig. 37 of King's monograph, or Pl. I, fig. 7 of the monograph of Mr. Davidson, the similarity of these figures to the one on our Plate XXV is so striking that it cannot be doubted that the specimens represented by all these figures belong to one and the same species. If I were to adopt Mr. Davidson's view in the matter, I would have to quote the Indian shell, not as *Diel. elongatum* but as *Terebratula sacculus*, Martin, as both these forms belong to one and the same species. But what would be the use of such a quotation ? The simple mention of a name like *Ter. sacculus*, a thoroughly carboniferous species, would immediately suggest a carboniferous age for the beds in which it occurs, and yet the form which, in fact, occurs, has not the slightest similarity to the average form of *Terebratula* occurring in carboniferous strata ; on the contrary, it can only be more particularly compared to the average form of *Terebratula* occurring in permian beds. Thus the quotation of *Diel. sacculus* in the Salt-range would simply be misleading as to the probable age of the beds in which this fossil occurs as well as to the real affinities exhibited by the specimens. This is a most striking example, how necessary the more minute

distinction of the species for the proper determination of the age of a bed may be ; though I will not say that, by the occurrence of *Diel. elongatum* in the Productus-limestone, these beds will irrevocably pass into the permian formation.

3. *DIELASMA NUMMULUS*, Waagen, n. sp., Pl. XXV, fig. 9.

This species is in its general form closely related to *Diel. elongatum*, Schloth. sp., but yet differs so far from it in several important characters that I think it more correct to describe this shell as a distinct species.

The general form is nearly circular, very little elongated, and in no way pentagonal; both valves are flattened; the beak is small and distinctly bent over; the frontal line nearly straight and but very little raised in the middle.

The ventral valve is not quite regularly vaulted, as, longitudinally, the curve from the end of the beak to about the upper third of the length of the valve is rather abrupt, and from there it is rather gradually tapering to the frontal line. The beak is truncated just at its extremity by a round, and not very large foramen. From both sides of the foramen to the lateral parts of the shell two indistinct ridges descend in a gentle curve, marking off an indistinct false area. The beak is so firmly adpressed to the apex of the dorsal valve that it cannot be seen whether deltidial plates are present or not.

The dorsal valve is even more flattened than the ventral one, and is nearly quite circular in its outline, the apex being but very little projecting. The line in which the two valves meet is very nearly straight all round.

The surface of the shell is entirely smooth, and even with the lens barely any striæ of growth can be seen. The punctation is excellently preserved in the specimen under description, but it is so fine that it becomes almost microscopical, and can only be observed with a very powerful lens, and is much finer than that of *Diel. elongatum*.

In the only specimen I have for description nothing can be seen of the internal characters.

The measurements are as follows :—

Entire length of the shell	21 mm
Length of the dorsal valve	19 "
Entire breadth of the shell	18 "
" thickness "	9 "
Apical angle of the larger valve	80°
" " " smaller "	114°

Locality and geological position.—The only specimen of this species that has hitherto been found was collected by myself at Katta in the very lowest beds of the compact limestones forming the middle division of the Productus-limestone (bed Nr. 12 of the section in my note-book).

Remarks.—This species belongs beyond any doubt to the group of forms to which also *Diel. elongatum* belongs; nevertheless I do not think that it should be

united with that species. The greatest difference consists in its nearly circular form, and in this respect it resembles more nearly *Terebratulata lata*, Schloth., which is, however, by most authors also considered only as a variety of *Dielasma elongatum*. There is, moreover, always a further marked difference in that the present species is quite rounded, whilst *Ter. lata* is more or less distinctly pentagonal. The sinus, too, in the larger valve is more strongly developed in Schlothheim's species than in the Indian shell, where it is nearly quite absent. Another marked difference consists in the lateral aspect of the shell, where the line in which the two valves meet is nearly quite straight in the Indian shell, whilst it is distinctly curved in *Terebr. lata*. This character indicates a different transverse curvature in the dorsal valve of the two species. Thus it seems to me probable that a distinct species is represented by the Indian specimens.

III.—GROUP OF *DIELASMA FICUS*, (M'Coy) Davidson.

4. *DIELASMA TRUNCATUM*, Waagen, n. sp., Pl. XXV, figs. 11, 13.

This rather large species has a somewhat pyriform general shape, is elongated, truncated in the frontal region, with a somewhat vaulted frontal line, and a very thick beak, which is strongly bent over, and bears a large oval foramen.

The larger, or ventral, valve is very strongly inflated, most so in the region near the beak, gradually tapering towards the frontal line. A short distance, however, before reaching it, it is abruptly deflected at an obtuse angle and ascends to meet the dorsal valve. The longitudinal curve of the valve is thus first (near the beak) nearly semicircular, then flattened, and at last geniculated. In the transverse direction this valve is considerably flattened in the middle and suddenly bent up on both sides. The beak is very thick and short, and strongly bent over. The foramen is oval, situated not quite on the apex of the beak, but somewhat behind it, a position which is similar to that occurring in *Ter. bovidens*, Morton. From both sides of the foramen indistinct ridges extend down the beak, marking off a very ill-defined false area.

The dorsal valve is about as much inflated as the ventral one, but its curve is more regular. From the apex to near the frontal line it is very regularly vaulted; it is then suddenly deflected and bends down upon the ventral valve. Transversely this valve is much more strongly vaulted than in the longitudinal direction.

The sculpture of the shell consists only in not very numerous and not very strongly developed striae of growth. The punctuation of the shell is very fine, as fine as in *Diel. elongatum*.

Of the internal structure of the shell only the very strongly developed dental plates can be seen. Of the septal plates or the loop nothing can be seen.

In young specimens the inflation of the valves is much less considerable, and the truncation in the frontal region is entirely wanting.

The measurements of two specimens are as follows:—

	I.	II
Entire length of the shell	35 mm.	12.5 mm
Length of the smaller valve	29 "	11 "
Entire breadth of the shell	22 "	9.5 "
" thickness "	19 "	5.5 "
Apical angle of the larger valve	51°	56°
" " " smaller "	63°	75°

Locality and geological position.—There are only two specimens of this species preserved in the Salt-range collection, which were both found by myself at Amb in a black, coaly sandstone forming part of the lower division of the *Productus*-limestone. From the same bed a great many specimens of *Chonetes* were obtained, so that I called the bed "*Chonetes* bed" in my note-book.

Remarks.—This shell, when full grown, is very singular in its shape, and cannot easily be mistaken. It resembles none of the hitherto described forms more particularly, though it cannot be denied that it stands in a certain relation to *Diel. ficus* as figured by Davidson, Mon. Carb. Brach., Pl. I, fig. 13; the great inflation in the region of the beak is similar in the two species, but the development of the frontal region is peculiar in the Indian shell. In young specimens distinctive characters are not displayed, so they resemble *Diel. elongatum* or *Ter. bovidens*; they seem, however, to be distinct from these shells by a somewhat smaller apical angle.

Another species which might be compared is *Diel. plica*, Kutorga. The typical form of this species, as figured by Kutorga, shows very little resemblance indeed, but V. v. Moller in his monograph of the carboniferous Brachiopods of the Ural, besides the typical form which is represented Pl. I, fig. 3 of the monograph, figures another variety which he considers to belong also to *Ter. plica*, but which very likely represents another species, and to which figs 4, 5, and 6 will correspond. This species is in general outline very similar to *Diel. truncatum*, but can be distinguished by an impression extending all along the ventral valve from the beak to the front, and by the sharper margins, chiefly in the frontal region.

5. *DIELASMA MINOR*, Waagen, n. sp., Pl. XXV, fig. 12

Together with the species just described there occurs another shell, which in most respects agrees with *Diel. truncatum*, but which is distinct by its shorter and comparatively broader form, larger apical angle and much less considerable size.

The general form of this shell is somewhat pentagonal, the greatest breadth being situated about in the middle of the length of the shell, from there it tapers towards the beak as well as towards the front. Both valves are about equally inflated, the larger one more so in the region of the beak, the smaller one more in the frontal region. The beak is very short and very thick, perfectly rounded, distinctly bent over and pierced a little behind its apex by a very large oval foramen. The false

area on both sides of the beak is very small and indistinct, and not even by the slightest indication of ridges is it limited off from the remainder of the shell.

The front of the shell is remarkable by its truncation, which is similar to that of the preceding species, and is produced by the sudden deflection of both valves all round towards the line in which the two valves meet. In the smaller valve the apex is very distinctly elevated, and there extends a ridge from the apex to the front, which broadens and flattens as it approaches the frontal region. On both sides of the apex the valve is strongly depressed and then spreads wing-like to its largest transverse extension. This feature is not well expressed in the drawing Pl. XXV, fig. 12a.

Of the internal characters of this shell nothing can be seen. The granulation of the shell substance is in this species still closer and finer than in any of the preceding ones; in fact, it is so fine that it can only be seen under very favourable circumstances.

The measurements of the only specimen are as follows:—

Entire length of the shell	19 mm.
Length of the smaller valve	16 "
Entire breadth of the shell	15 "
" thickness "	10.5 "
Apical angle of the larger valve	78°
" " smaller "	123°

Locality and geological position.—The only specimen of this species that has been found up to the present was collected by myself at Amb in the lower division of the Productus-limestone in the so-called *Chonetes*-bed of my note-book, together with *Dielasm. truncatum*, W.

Remarks.—It appears probable that this species is only a variety of *Diel. truncatum*; still, there are such marked differences between them, and transitional forms have not been detected up to the present, that I prefer until more complete materials will be available, to consider the two shells as representing different species.

The characters by which the two species can well be distinguished consist in the shorter, broader, and more pentagonal form of *Diel. minor*. The apical angle in this latter shell is much more considerable than in *Diel. truncatum*, and it exhibits the characters of the full-grown shell (the truncation of the valves all round) of a size at which specimens of *Diel. truncatum* must still bear a sharp frontal line; it is thus probable that *Diel. minor* was always of a much smaller size than full-grown specimens of *Diel. truncatum*.

Of other than Indian shells none can be particularly compared to the present species. *Terebr. boidens*, Mort., is not quite dissimilar; chiefly the beak bears a certain resemblance, but the peculiar truncation of *Diel. minor* is absent in the American shell.

6. *DIELASMA ITAITUBENSE*, Derby, sp., Pl. XXVI, fig. 5.

1874 *Torebratula itaitubense*, Derby, Bull. Cornell Univers. (Science), Vol. I, No. 2, page 1, pl. II, figs. 1, 8, 8, 16; pl. III, fig. 24, Pl. VI, fig. 15.

The species is of rather large size, elongated, flattened, with sharp margins and a not very large beak.

The ventral valve is flattened, broad, elongated, oval. The beak is distinctly bent over, not very thick, long and entirely free, not adpressed to the apex of the dorsal valve. The foramen is triangular, and apparently piercing just the apex of the valve; it is not very large, and appears to be limited on its lower side by small deltidial plates. From both sides of the foramen very sharp and distinct ridges originate, producing the triangular shape of the foramen; they descend in a slight curve to the lateral parts of the valve, thus marking off a rough, but rather distinct false area. In the frontal line the ventral valve is only very slightly produced, causing the frontal line to ascend a little and to form a very slight arch. This arcuation of the frontal line appears in the specimen which serves for description much stronger than it is in reality, owing to a malformation in the specimen in the process of fossilisation, as can be well seen from the cracks in the shell. As the specimen has been exactly copied by the artist, this arcuation of the frontal line is equally exaggerated in the figure.

The dorsal valve is also flattened, more strongly arched in the transverse than in the longitudinal direction, and a little bent up in the frontal region, according to the arcuation of the frontal line.

Of the internal characters of this shell nothing can be seen. Nevertheless it is highly probable from the near relation it seems to exhibit to *Diel. hastatum*, Sow., that it belongs to the genus *Dielasma*.

The substance of the shell exhibits under the lens very distinctly a close and fine granulation, which is, however, not so fine as in the species described on the foregoing pages.

The measurements of the only existing specimen are as follows:—

Entire length of the shell	. . . . .	41 mm.
Length of the smaller valve	. . . . .	38 "
Entire breadth of the shell	. . . . .	31 "
" thickness "	. . . . .	14 "
Apical angle of the larger valve	. . . . .	62°
" " " smaller "	. . . . .	85°

The thickness as measured is probably too small, as the specimen has suffered somewhat from pressure; it may very likely be as much as 16 mm.

Locality and geological position.—The only specimen of this species that is contained in the Salt-range collection was found by myself in black calcareous beds at Nursingpahár, on the limit between the middle and lower divisions of the Productus-limestone.

Remarks.—From all the forms of Brachiopods that have hitherto been described out of carboniferous deposits, *Ter. itaitubensis* from Brazil is the only one that can be particularly compared to the Indian shell just described, and it seems to be so far identical in all its characters to our Indian fossil that I thought it proper to apply the above name also to the latter.

The most striking characters the species possesses consist in the considerable flattening of both valves towards the frontal region, the very slightly arched or nearly straight frontal line, and the overhanging and strongly carinated beak. The Indian specimen is somewhat broader in comparison to its length than the specimens that have been figured by Derby from Brazil, but this single difference seemed to me not sufficient to distinguish the Indian shell as a separate species.

Of other species *Dielasma ficus*, M'Coy, is most nearly related, but can easily be distinguished by its much more inflated valves, and non-carinated beak. *Diel. cymbiformis*, Dana, from Australia has very nearly the same characters as *Diel. ficus* but is distinguished from this species chiefly by its more broadly ovate form and the concentric undulations of the shell. From *Diel. itaitubense* it can be distinguished in the same manner as *Diel. ficus*.

An European carboniferous shell which by its flat valves, long thin beak, and nearly straight frontal line recalls to a great extent the form of *Diel. itaitubense* is *Diel. hastiforme*, Kon. sp., but this species seems not only never to attain the size of the Indian shell, but is also devoid of the lateral carinations on the beak which are so characteristic of Derby's species.

IV.—GROUP OF *DIELASMA BIPLIX*, Waagen.

7. *DIELASMA BIPLIX*, Waagen, n. sp., Pl. XXV, figs. 3, 4, 5.

This species is somewhat variable in its general outline. It is always more or less distinctly pentagonal, but some specimens are about as long as they are broad, whilst others are much more elongated, and then their pentagonal outline is much less distinctly developed.

On the dorsal side of the shell two strong straight folds start from the apex of the smaller valve, whilst on the ventral side only one mesial fold exists. The frontal line is vaulted, with a sinuation in the middle as in biplicate *Terebratulæ*.

The larger, or ventral, valve is very regularly arched in the longitudinal direction, but it is generally flatter in young specimens than it is in old full-grown ones. In the transverse direction on the contrary its arcuation is rather irregular. In young specimens it is everywhere flatly vaulted, but in old ones it becomes nearly quite flat in the middle of its length. Laterally this valve is rather strongly cut out for the reception of a lobe coming from the dorsal valve. The beak is not long, tolerably thick and distinctly bent over. It is pierced just behind the apex by a tolerably large oval foramen. The deltidium is not very large, but distinctly visible in some specimens. The false area, which adjoins the beak on its lower lateral part, is

tolerably broad, but not distinctly marked off from the remainder of the shell. From the middle of the length of the ventral valve a well developed but not very broad or high obtuse ridge extends towards the frontal line, and is shut in on both sides by low rounded excavations, corresponding to the zigzag bend of the frontal line. The whole frontal part of this valve is distinctly bent up.

The dorsal valve is nearly quite straight, only slightly vaulted longitudinally, but is strongly bent transversely, and generally more so than the ventral valve. This bent condition causes the dorsal valve to form on both sides a kind of lobe or prominence, which fits into a broad sinuation of the margin of the ventral valve. From near the apex there start two strong, perfectly straight rounded folds which get stronger the nearer they approach the frontal line. Between them a deep valley is formed, which commences not far from the apex as a low, flat depression of the shell, and is deepest on the frontal margin. Near the apex, which is rather pointed, the margins of this valve are slightly excavated, and then descend in a broad, prominent arch to the zigzag frontal line.

The internal structure of this shell is not known to me in every detail, but in some of the specimens it can distinctly be seen that strongly developed dental as well as septal plates are present.

The punctuation of the shell, which can be very distinctly seen on two of the specimens, is extremely fine but not very close, but, on the whole, much finer than in any of the species described on the foregoing pages.

The measurements of the three figured specimens are as follows:—

	I.	II.	III.
Entire length of the shell	38 mm.	27 mm.	21 mm.
Length of the dorsal valve	30 "	25.5 "	19.5 "
Entire breadth of the shell	21 "	20 "	18 "
Entire thickness "	14 "	11 "	9 "
Apical angle of the larger valve	65°	65°	70°
" " " " smaller "	100°	103°	105°

The shell is widest about the middle.

Locality and geological position:—There are altogether three specimens of this species in the Salt-range collection. One of them was found by myself at Virgal in the white crinoidal limestone forming the middle division of the Productus-limestone. The two others were collected by a native servant called Mogul and have been communicated to me by Dr. H. Warth. One of them is from Vurcha, preserved in a reddish hard limestone, and comes beyond doubt also from the middle division of the Productus-limestone. The other comes from Musakhayl and is silicified. The numerous silicified shells which have made this locality celebrated come out of a bed which must be assigned to the middle division of the Productus-limestone, and it is thus highly probable that also this third specimen was found in that division. From this it is probable that all our specimens of *Diel. biplex* came from the middle division of the Productus-limestone, and that the species is restricted to that division.

Remarks.—This species seems to be somewhat variable chiefly as to its length, breadth and thickness. By the three specimens figured on Pl. XXV these variations are well brought out. Whilst fig. 3 represents a very short and broad, nearly pentagonal variety, which is also rather flat, the other extreme as regards length and thickness is represented in fig. 5. The apical angle is also slightly variable in different varieties. One character however, which can very easily be recognised, and which is highly characteristic for the species, and common to all the varieties, is the presence of strong, straight folds, which start from near the apex of the dorsal valve and reach down to the frontal line. It is by this character that this species can be distinguished from *Diel. problematicum*, (Dav.) W., and the other species which will have to be described hereafter.

Of non-Indian shells there are very few which could be compared to the present one. Of all that are known to me from the carboniferous deposits of Australia, *Rhynchonella inversa*, Kon., is the only one that possibly could be compared to our *Dielasma biplex*. The general arrangement of the plications, the somewhat pentagonal shape, the thick overhanging beak, truncated by an oblique large foramen, all these are points of similarity which cannot be denied. M. de Koninck does not state his reasons for considering this shell as a *Rhynchonella*. The figure, with its thick truncated beak, certainly recalls the form of a shell belonging to the *Terebratulidae* rather than that of a *Rhynchonella*.

Of *Terebr. bisinuata*, M'Coy, which might possibly resemble the present species, and which also occurs in the carboniferous deposits of Australia, neither figures nor description are accessible to me.

8. *DIELASMA PROBLEMATICUM*, (Dav.) Waagen, n. sp., Pl. XXVI, figs. 3, 4.

1862. *Terebratula bicipitata*, Brocchi (?), var. *problematica*, Davidson Quart. Jour. Geol. Soc., Lond., Vol. XVIII, p. 26, pl. I, fig. 3.

1863. *Terebratula bicipitata*, Brocchi (?), var. *problematica*, (Dav.) Koninck Foss. Paléoz. de l'Inde, p. 31, pl. IX, fig. 3.

The general outline of this species is somewhat trapezoidal or elongately pentagonal, the greatest breadth of the shell being situated high up, not far from the beak. The shell is very strongly inflated, but the two valves are vaulted in an opposite direction. Whilst the ventral valve is curved longitudinally, the dorsal one is vaulted transversely. The frontal line is bicipitate.

The ventral valve is longitudinally very strongly but very regularly vaulted, and it is only slightly more curved in the region of the beak than in the frontal part. In the transverse direction, on the contrary, it is for the greater part of its length, beginning not far from the beak, nearly entirely flat or even slightly excavated, as shown by fig. 3c on Pl. XXVI. In all the specimens that have been found up to the present a more or less prominent rounded longitudinal ridge is present on the ventral valve, which generally commences about the middle of the

length of the shell and, growing slowly stronger, reaches down to the frontal line. In some specimens this ridge is limited only to the frontal part, whilst the remainder of the ventral valve is smooth; in others, but very rarely, this ridge commences already on the beak and thus extends over the entire length of the shell. In these latter specimens it is at the same time more strongly developed than in others. In every case this ridge is accompanied on both sides by depressions, more or less deep, which commence where the ridge begins and extend to the frontal line, corresponding there to two projecting parts of the valve, causing the plications of the dorsal valve.

The beak is not very thick, nor prominent, but well bent over. It is obliquely truncated by a tolerably large oval foramen, which pierces the beak just behind its apex. The deltidium is well developed but mostly concealed. On both sides below the beak a broad false area extends; there are, however, just the slightest traces of ridges which would define the false area from the remainder of the shell.

The dorsal valve is very characteristic by its general configuration. It appears very flat when seen in profile, as it bends but very slightly inside in the region of the apex, and is otherwise perfectly straight. The bend of this valve appears, however, perfectly different in a transverse section of the shell, or, if we consider the front view as represented in fig. 3c of Pl. XXVI, in which the lateral parts of the shell are strongly depressed, whilst the middle part is strongly elevated; an appearance which is caused by the lateral parts of this valve forming broad, rounded lappets, hanging so far down on both sides of the shell, that, in a profile or side view, the ventral valve is entirely concealed by the dorsal one from about the middle of the length of the shell down to the front.

The dorsal valve is ornamented by two strong folds, separated from each other by a deep groove; they commence about the middle of the length of the valve, but never at the apex, and reach down to the frontal line.

Both valves show a number of striae of growth, which are, however, never very conspicuous.

Of the interior arrangement of this shell nothing but two very strongly developed dental plates can be seen.

The punctuation of the shell is as fine in this species as in the preceding one, but there are many slightly larger pores irregularly disseminated between the smaller ones.

The measurements of three specimens, I and II from Morah, No. III from Musakheyl, are as follows:—

	I.	II.	III.
Entire length of the shell	86mm	29 mm	19 mm
Length of the smaller valve	81 "	25 "	17 "
Entire breadth of the shell	24 "	17 "	13 "
" thickness "	19 "	14 "	11 "
Apical angle of the larger valve	77°	75°	68°
" " smaller "	?	110°	95°

Locality and geological position.—There are altogether four specimens of this species in the Salt-range collection. Two of them were found by Mr. Wynne at Morah in the middle region of the Productus-limestone; one, the largest, is only a ventral valve and is contained in a very hard white limestone; the other, smaller, comes out of a yellowish, slightly oolitic marly limestone. Another specimen, a fragment of a dorsal valve was collected by myself in the mountains east of Katwáhi in a very hard, compact, white limestone forming the lower part of the middle division of the Productus-limestone in that country. The last specimen was furnished to me by Dr. H. Warth and was collected by his servant Mogul at Musakheyl. The specimen is silicified and was evidently obtained from the particular bed that has yielded so many other fossils from that locality, that is to say out of the upper region of the middle division of the Productus-limestone. The species thus seems to occur in different horizons within the middle Productus-limestone, but seems not to descend into the lower nor to go up into the upper division of the same formation.

Remarks.—This species is most strikingly characterised by its short folds, which never reach the apex of the smaller valve, and by the greatest breadth of the shell being situated not far from the apex, producing an outline as of shoulders, from which the shell tapers more or less regularly towards the frontal line. These are the characters by which this species can most easily be distinguished from other allied forms, such as *Diel. biplex* described above, in which species the folds reach up to the apex of the smaller valve, and the greatest breadth is situated about the middle of the length of the shell.

Terebratula buplicata, Brocchi, with which this shell has been compared by Mr. Davidson, may be similar in its general outline, but the strong dental plates which can easily be stated to exist in every specimen are absent in the cretaceous species, and, thus, there can be but very little doubt that the Indian shell is widely different from Brocchi's species.

9. *DIELASMA ACUTANGULUM*, Waagen, n. sp., Pl. XXVI, figs 1, 2; Pl. XXV, fig. 7.

This very interesting species is characterised by its narrow elongated shape, rather flat valves, and a sharp, slightly biphate frontal line.

The ventral valve is regularly but not strongly curved in both directions. Longitudinally the curvature is a little stronger on the beak than in the frontal region, and also transversely this valve is more strongly vaulted near the beak than near the front. In the frontal region this valve is produced into two bent-up lappets corresponding to the two folds of the dorsal valve. Between these two lappets, which are slightly depressed, the margin of the valve is cut out correspondingly to a slightly elevated rounded ridge, which extends a little way up the shell. The beak is small and well bent over, pierced just behind its apex by a

rather small roundish foramen. The false area extending on both sides below the beak is tolerably broad, and reaches far down on both sides of the shell. It is limited above by a very indistinct, obtuse ridge, which commences on both sides of the foramen and terminates low down at the lateral parts of the valve.

The dorsal valve is not quite so strongly vaulted as the ventral one. In a longitudinal direction it is very flat, and deviates but little from the straight line. Only near the apex it is somewhat more strongly curved, but in the frontal region it appears sometimes as if impressed, which causes the extreme sharpness of the front. Transversely this valve is much more strongly vaulted than longitudinally, and equals in that respect the curvature of the ventral valve. In the apical region this transverse curvature produces peculiar features in most of the specimens. From both sides of the apex flat triangular spaces descend along the margins of the valve, forming part of the false area, which thus encroaches upon the smaller valve. These flat spaces are divided from the remainder of the valve by very obtuse, barely perceptible ridges.

In the frontal region of this valve there are two more or less strongly developed short folds, which are entirely absent in young specimens, and are even in old ones often so very little expressed that they might easily be overlooked. In other specimens they are more strongly developed, but never more so than in Fig. 1 on Pl. XXVI.

This species is very apt to display the internal characters, as it is generally very completely silicified, and with diluted acid the internal structure is readily exposed. Yet it is not easy to get a complete loop, as most specimens have received slight cracks by pressure, and the loop falls to pieces when the matrix is removed. From all that I have been able to observe, I cannot but doubt that the loop was short and very much like that in *Terebratulula*, the crura remarkably straight, attached for a rather long way to the dental sockets, which are long and very strongly developed. At the place where the crura get detached, two long convergent spurs are situated. From there the crura descend quite straight, and are then united by a small curved and tolerably broad cross-piece, without any recurring branches. At the apex there is a rather strongly developed cardinal process. Immediately below this process a broad triangular slit commences, limited on both sides by the attached parts of the crura. Between these one looks down to the bottom of the shell. Here, very near the middle line, the two septal plates take their origin and ascend in an oblique direction to be joined to the bottom of the dental sockets. Between these plates, the sockets and the external shell, a triangular pyramidal hollow space is separated from the remainder of the space of the shell, commencing with its very pointed apex at the cardinal process and reaching down as far as the septal plates extend. These latter are very long in this case, attaining nearly the length of the loop. At the point where the septal plates terminate as low ridges, the impressions of the two anterior adductors are situated rather far apart, separated from each other just by this last extension of the septal plates. Further up, situated partly on the

septal plates and partly on the bottom of the shell the impressions of the two posterior adductors can be observed; they are much smaller than those of the anterior adductors, are very close together, and nearly touching each other in the median line.

In the ventral valve two very strong dental plates are present, but the muscular impressions could not be made out.

The vascular impressions can be seen on a partial cast, in which however the apical region is concealed. Two strong veins are observable in the dorsal valve; these originate apparently on the inner side of the anterior muscular impressions and extend, in a slightly divergent direction, towards the two folds of the valve. They do not seem to ramify much. On the lateral parts of the valve these two principal veins are followed by several others of smaller size, which go in a nearly parallel direction, diverging only very slightly towards the lateral margins of the valve. In the ventral valve one very strong median vein is observable; it commences about where the dental plates disappear and extends for about one-third of the entire length of the shell. Near its lower end, on both sides, a number of smaller veins appear, which are also nearly parallel, and stretch down to near the lower lateral margin of the valve with but slight divergence. In all these veins no distinct ramifications can be observed.

The measurements of two specimens, one from Jabi, the other from Chidru, are as follows :—

	I	II
Entire length of the shell	27 mm.	26.5 mm.
Length of the smaller valve	25 "	24.5 "
Entire breadth of the shell	16.5 "	16 "
" thickness "	10 "	10 "
Apical angle of the larger valve	55°	53°
" " of the smaller "	77°	73°

Individuals of this species seem to grow much larger than the specimens of which I have given the measurements. There are some fragments which indicate a shell of at least 38 mm. in length, whilst at the same time their breadth has not been more than 19 mm. and their thickness 16 mm. The region of the beak gets very much inflated in these large specimens, and, in consequence, the apical angle of the larger valve decreases considerably as the shell grows larger, so that in one of the fragments mentioned it is not more than 35°.

Locality and geological position.—Several specimens of this species were collected by myself at Jabi and Chidru, at both localities in the so-called Cephalopoda-bed. At the first locality I found six specimens together with *Cyclolobus oldhami*, W., described on the foregoing pages, whilst at the latter locality four specimens were detected by me in the bed with *Xenodiscus carbonarius*, W. Only one fragment of a large specimen was found by me at Chidru in beds a little above the *Xenodiscus carbonarius* bed. It is thus evident that this species is most characteristic of the Cephalopoda bed of the upper division of the Productus-

limestone, and that it is only very rarely met with in beds a little above the one mentioned.

Remarks.—The most striking feature of this species is the very small apical angle and the very elongated shape the shell attains. The slight development of the frontal folds led me formerly¹ to compare this species to *Diel. elongatum*, Schl. sp., a comparison which cannot stand any longer, as nothing but a generic affinity exists between the two forms.

Of the shells hitherto described only *Diel. problematicum*, (Dav.) Waagen, can be more particularly compared, but this species can easily be distinguished from the one here under consideration by its larger apical angle, less elongated form, and the particular curvature of its dorsal valve. The affinity between the two forms is, however, not so close that it could be affirmed or made to appear probable that the two species are in a developmental connection, though both occur in succeeding strata.

10. *DIELASMA BEEVIPLICATUM*, Waagen, n. sp., Pl. XXV, figs. 6, 8; Pl. XXX, figs. 11, 12.

The general form of this shell is more or less pentagonal, rather broad in comparison with its length. It is mostly rather flat and provided in the frontal region on the dorsal valve with two short folds.

The ventral valve is very equally arched, sometimes less, sometimes more, but there is no difference between the curvature on the beak or that near the frontal region. Also, in the transverse direction the ventral valve is everywhere well vaulted, never flat or excavated as in *Diel. problematicum*. The raised rounded ridge which ornaments this valve in *Diel. biplex* or *problematicum* is here absent, and only on the frontal region a slight elevation is observable according to the folding back of the biplicate frontal line. The beak is not very large and not much bent over. It seems to be pierced just at its extremity by a not very large round foramen. A distinct small deltidium is present, but it is rarely visible. The false area which extends from both sides of the foramen is tolerably broad, and separated from the remainder of the shell by a very obtuse ridge, which extends from the sides of the foramen to the lateral parts of the valve.

The dorsal valve is longitudinally very little less vaulted than the ventral one. Transversely the curvature of both valves is absolutely equal, only that the lateral parts of the dorsal valve are a little more deflected than the remainder of the shell, and thus hang down a little, thereby recalling, to a certain extent, the shape of the dorsal valve of *Diel. problematicum*. In the frontal region the dorsal valve bears two short folds, which do not extend even up to the middle of the length of the shell but are entirely limited to the frontal region. Nevertheless, they are some-

¹ Mem. Geol. Surv., Ind., Vol. IX, p. 363.

times very strongly developed, and even generally well expressed, only in few specimens are they but slightly indicated.

The internal arrangement in this species could be well studied in some silicified specimens, which were treated with diluted acid; but in this case also the internal parts could only be studied during the process of developing, as on removal of the matrix they immediately fell to pieces owing to numerous minute cracks, by which they were traversed. At the apex of the dorsal valve there is a very distinctly developed cardinal process, at both sides of which the two extremely long dental sockets take their origin. They are formed by a shelly plate, which is fixed to the cardinal margins of the valve and first bends down and then up again, forming a high crest, which limits the dental socket on the inner side, and descends obliquely to the bottom of the valve, being fixed there for its entire length. Joined to these shelly laminae forming the dental sockets and the septal plates, are the upper parts of the crura, which originate at the cardinal process, and extend across the septal plates, projecting from them as sharp, narrow, prominent margins. The space between these latter is free from shelly matter up to the very cardinal process, and, thus, it can hardly be said that there is a hinge-plate. At the bottom of the valve, which is thus exposed to view, a thickened prominent line is observable, which takes its origin just below the cardinal process, and descends as far as the septal plates extend, following exactly the median line of the dorsal valve. If then the septal plates are very oblique, which is sometimes the case, they are no longer joined to the bottom of the valve, but reach this raised middle line, and then it appears as if a septum were present, and the whole apparatus takes a shape very much like that figured by Davidson (Brit. Perm. Brach., pl. I, figs. 18-20) of *Diel. elongatum*, Schl. sp. At the point where the crura get detached from the septal plates, the oral processes or spurs are situated and converge directed slightly upwards and inwards towards the middle of the shell. They are in no way very large or conspicuous. The crura themselves descend in a remarkably straight manner for more than half the length of the valve, diverging considerably as they extend, so that their lower ends are rather far apart. They terminate in sharp points. Recurring branches do not exist. The cross-piece is not well preserved in any of the specimens I was able to examine. It seemed broad and very little curved, remarkable also by its comparative straightness.

In the ventral valve two very long and very strongly developed dental plates are present. The hinge-teeth are developed as long and high ridges, which extend from both sides of the deltidium along the hinge margin, and are separated from the latter by a deep furrow. They are highest at their lower extremity, and united at their inner side to the dental plates, which ascend vertically to the roof of the valve. These two plates surround the foramen laterally, and then, fastened on the one hand to the roof of the valve, on the other to the hinge-teeth, extend in a divergent direction to about one-third of the entire length of the shell.

The muscular impressions could only be observed in the dorsal valve; in the

ventral one even, with the utmost care, they could not be detected. In the dorsal valve the impressions of the anterior adductors are most conspicuous. They are large, and about the shape of a pointed leaf, the pointed side being turned towards the apex of the valve. The point is situated a little above the lower termination of the septal plates, and from there the impression extends nearly parallel to the middle line of the valve. The impressions of the posterior adductors are much smaller, of an oval shape, and situated between the two pointed extremities of the impressions of the anterior adductors. They are separated from each other by the elevated middle line which I have described above, and from the impressions of the anterior adductors by the ridges which form the last extension of the septal plates.

The punctation of the shell is extremely fine, and the punctures show some tendency to be arranged in radial rows.

The measurements of two middle-sized specimens, No. I, from Chidru, No. II, from Khura, are as follows:—

	I.	II
Entire length of the shell	25 mm	24 mm
Length of the smaller valve	28 "	22 "
Entire breadth of the shell	19 "	16 "
" thickness "	10 "	11 "
Apical angle of the larger valve	82°	75°
" " of the smaller "	110°	102°

Shells of this species attain to much greater dimensions than those of the specimens of which the measurements are here given, but no complete specimen of larger size has yet been obtained.

Locality and geological position.—There are altogether six specimens of this species in the Salt-range collection, and all came from different beds of the upper division of the Productus-limestone; it thus appears that this species, in opposition to that last described, which is limited chiefly to the *Cephalopoda*-bed, is characteristic of the whole upper division of the Productus-limestone, not limited to any particular bed. It was found in this upper division by myself at Khura, (1 specimen), at Chidru (1 specimen), and by Mr. Wynne in the Bazár Wán (1 specimen). Besides these, one specimen was collected by myself in the *Cephalopoda*-beds of Chidru and two specimens in the same bed at Jabi.

Remarks.—This shell is allied chiefly to two of the before described species, *Diel. problematicum* and *Diel. acutangulum*. With both it has the short folds on the frontal part in common, but it can very well be distinguished from the first by the much smaller curvature of its valves, and chiefly by the fact that both valves are about equally vaulted, longitudinally as well as transversely, which is not the case in *Diel. problematicum*; from the second it differs very considerably by its much larger apical angle and comparatively short shape, as well as by some peculiarities of its internal arrangement.

With some varieties of *Diel. bplex*, W., the present species has the short

pentagonal form and flatness of the valves in common, but it can easily be distinguished by the short frontal folds, which in *Diel. biplex* reach up to the apex of the dorsal valvo.

There is little doubt but that *Diel. breviplicatum*, W., is developmentally connected with some of the geologically older forms, *Diel. biplex* and *Diel. problematicum*, more probably with the former than with the latter, on account of the similarity in the general curvature of the valves which exists in the first case.

Genus: *DIELASMINA*, Waagen, n. gen.

Already in the introduction to the subfamily *Terebratulinae* I have briefly characterised this genus.

From the specimens contained in the Salt-range collection, it appears that the shells belonging to the genus are characterised by a more or less globose form, strong and irregular radial plications, which do not cover the whole shell, but are limited to the marginal parts, and internally by the existence of strong dental and not less strong septal plates.

The materials for this genus available are very small indeed, and thus it has not been possible to develop the loop out of the matrix, or to make sections through the shell in order to ascertain the extension and shape of the loop. Nevertheless, it is nearly certain that the species belonging to this genus possessed a short loop, as do the other shells of the subfamily *Terebratulinae*.

On the whole this genus occupies a truly transitional place between the genera *Dielasma*, King, and *Hemiptychina*, W. The strong development of dental and septal plates agrees with *Dielasma*, whilst the external shape of the shell is exactly like that of *Hemiptychina*.

The view might be advocated that the shells belonging to this genus ought to be simply included under the genus *Dielasma*, and that the creation of a new genus is superfluous. This view might be reasonable, if the opinion were held that all the shells forming the subfamily *Terebratulinae* ought to be considered as forming only one genus; but if Douvillé's and other genera be accepted, even only to a certain extent, the creation of this genus can barely be avoided. *Dielasmina* differs from *Dielasma* quite as much as *Pygope*, Link, differs from *Terebratula*, and it is only a consequence of the system that the shells bearing the characters of *Dielasmina* must be considered as constituting a proper genus.

Only one species belonging to this genus is known to me,—this is *Dielasmina plicata*, Waagen,—which occurs in the Salt-range in the uppermost beds of the middle division of the Productus-limestone, and in the upper division of the same formation.

1. *DIELASMINA PLICATA*, Waagen, n. gen. et sp., Pl. XXVII, fig. 10.

The general form of this shell is more or less globular, with very much inflated valves, strongly plicated at their margins, with a slightly vaulted frontal line and a small but well curved beak.

The ventral valve is very strongly vaulted in both directions, longitudinally as well as transversely. The longitudinal curvature is equal throughout the whole extent of the shell in one specimen, whilst in another specimen it shows a sudden bend not far from the frontal region. The frontal part is a little produced in this valve, so that the frontal line appears slightly vaulted. From the beak to about half the length of the valve the shell is entirely smooth, and even striae of growth can barely be observed. After this the shell becomes undulating, the undulations being at first very indistinct, and only as the shell expands are distinct radial folds formed, reaching down to the margin of the valve. The number of these folds is somewhat variable, and in this valve it is four to five in the frontal region and two more on each lateral part. The frontal and lateral margins of the valve form a zigzag line. The beak is small, well bent over, obliquely truncated, and distinctly pierced behind its apex by a narrowly oval foramen. A false area can hardly be said to exist, the beak being so perfectly rounded. Slight impressions on each side below the apex replace the false area. The deltidium is concealed in the two specimens I have studied.

The dorsal valve is even more strongly vaulted than the ventral one in both directions, but longitudinally its curvature is very unequal. Beginning from the apex it seems rather flat and straight until having reached about half its length, when it first bends down in a strong curve and then even curves over, so that this curved part of the dorsal valve overhangs the frontal line considerably. Where the valve begins to bend its plication also commences, and stretches thence down to the margins of the valve. There are either three or four folds on the frontal part, and three more on each side of it.

Of the internal arrangement of this species the loop is not known to me, but in both the existing specimens very strong and long dental plates can be observed in the ventral valve. Between these, following the middle line of the valve a thickened shelly line exists, commencing at the margin of the foramen and extending yet a little farther than the dental plates. In the dorsal valve the dark lines in which the septal plates unite with the valve can be very distinctly traced. In the middle line of the valve, beginning at the apex, there is a very strongly marked, prominent, shelly ridge not unlike a septum but much less high, exactly like that described a few pages back in *Diel. breviplicatum*, W.

The substance of the shell is extremely finely punctured.

The measurements of two specimens, No. I from Khura, No. II from west of that village, are as follows :—

	I.	II
Entire length of the shell	22 mm	22·5 mm
Length of the smaller valve	19 "	20 "
Entire breadth of the shell	17 5 "	17 "
" thickness "	16 5 "	16 "
Apical angle of the larger valve	67°	68°
" " of the smaller "	110°	113°

Locality and geological position.—Only two specimens of this species exist in the Salt-range collection, both of which were found by me. One I got in the section at Khura, in thin bedded light coloured limestones forming the upper part of the middle division of the Productus-limestone. The other I found in the section west of that village in yellow marly beds forming the very base of the upper division of the Productus-limestone.

Remarks.—Up to the present no palæozoic shell has been described which could be more particularly compared to the present species. *Terebrat. himalayensis*, Dav., has similarly arranged folds, but is much less inflated, and has no dental plates, as will be shown in the description of that species further on in this work. Of other shells jurassic species chiefly may be compared with *Dielasmina plicata*, and some are, according to their external form, even very similar. Among these are notably *Terebrat. fimbriaformis*, Schaur., or *Terebrat. renierii*, Cat. On close examination of these forms, however, it soon becomes evident that the similarity to *Dielasmina plicata* is only an external one, as the dental plates which characterise the genus *Dielasmina* are absent.

Genus: HEMIPTYCHINA, Waagen, n. gen.

In the introduction to the subfamily *Terebratulinae*, I have already given a short diagnosis of the genus, and it remains now only to add some words more on the geological distribution of the genus, &c.

The genus is distinguished very characteristically from the greater number of palæozoic *Terebratula* by the absence of dental plates in the ventral valve. In this respect it approaches more closely the mesozoic forms, in which dental plates are nearly always absent. The septal plates which the present genus possesses, though more peculiarly characteristic of palæozoic shells, are not restricted to shells from those periods, as species with septal plates still occur commonly in the oldest periods of the mesozoic era.

The loop itself is exactly like that of *Terebratula* proper, and is even less peculiar than, for instance, that of *Dielasm. breviplicatum*, W., described above.

The plication of the shell, though the specific name points to this character, is not absolutely indispensable for the shells belonging to the genus. Not only do young shells generally appear to be smooth, the plication commencing only after

the shell has attained a certain size, but in some cases full-grown shells also are absolutely devoid of plication, though this latter case appears to be only the exception to the rule, plication being generally present.

It is almost certain that the genus existed already during the devonian period; and there is but very little doubt that some of the species of *Terebratula* described by Hall in the fourth volume of his Palæontology of New York belong to this genus. After this, however, there is a great gap, as I know of no species in the mountain-limestone proper that I should like to attribute to the genus. The small group of forms belonging to the genus in the Salt-range appears to be rather isolated, as in more recent strata no similar forms are known to exist up to the lias. The discovery of connecting links between the older devonian shell and the more recent liassic shells must be looked for.

The liassic shells which I have just alluded to appear in the lias of the Alps in grey limestones, which have been considered up to very recent times as belonging to the inferior-oolite according to the numerous and well-preserved plant remains they contain, but which have been shown by Zittel and others to be of liassic age. There are chiefly two species which must be taken into consideration; these are *Ter. rotzoana*, Schaur., and *Ter. renierii*, Cat., or *Ter. fimbriaformis*, Schaur. I had opportunity to study large numbers of these species, thanks to the kindness of Prof. Benecke of Strassburg, who sent me all the stock of these forms contained in the Strassburg Museum for comparison. Though the preservation of these shells is very little favourable to a close examination of the interior characters, yet so much could be made out that these shells very likely belong, in part at least, to the genus *Hemiptychina*. Zittel, in his palæontological manual, expresses the opinion that these forms probably were the precursors of *Waldheimia*, but I could not find a long loop either in *Ter. rotzoana* nor in *Ter. fimbriaformis*, Schaur. In both these forms the loop is not longer than half the length of the dorsal valve, and has no long recurving branches. Nevertheless the two shells differ more or less strongly from each other. *Ter. rotzoana* possesses a strong septum, to which the two short septal plates are fastened, exactly as is the case in *Ctenothyris*. In *Ter. renierii*, Cat., on the contrary, a septum is absent; the septal plates, which are also very short, as in *Hemiptychina*, are fastened to the bottom of the valve, and, as the dental plates in the ventral valve are also absent, there would be no reason for distinguishing this shell generically from *Hemiptychina*, except the development of the cardinal process in the dorsal valve, which is very strong and thick in *Ter. renierii*, whilst it is very small and little developed in all the species of *Hemiptychina*, as far as this part has been studied up to the present. Nevertheless it cannot be doubted that *Ter. renierii* is very nearly related to *Hemiptychina*, and both can be considered as being in a developmental connection. Thus, it is evident that the species of *Hemiptychina* occurring in the Salt-range represent more a mesozoic than a palæozoic type, as in the devonian formation shells probably belonging to *Hemiptychina* are very rare, in the mountain-limestone proper they are

entirely absent, and it is only in the Salt-range and in mesozoic formations of Europe that similar shells attain a greater development.

There is, however, yet another point worthy of consideration in connection with the two Alpine species. *Ter. rotzoana* is, as it seems, probably a *Cænothyris*, though the shield-like expansion on the transverse piece of the loop has not been observed up to the present (the dental plates in the ventral valve become also in typical forms of *Cænothyris* obsolete in adult specimens); whilst *Ter. renierii* should very likely be considered as a *Hemiptychina*; nevertheless, there exists a perfect transition of form between the two species, so that it would be possible to figure even more complete transitional series of these two than those that have been figured by Davidson of the different species of *Terebratula* occurring in the carboniferous formation. It must, however, be remarked, that such transitional forms are chiefly numerous at one locality, "Sega di Noviglio" near Rovereto, where *Ter. rotzoana* occurs in very great numbers, whilst *Ter. renierii* is much less numerous, but occurs intermixed with the other species. This occurrence of intermediate forms between the two species, I am now very much inclined to attribute to hybridity, which is so very easily effected in organisms where no special organs for copulation exist, but where the sea-water is the only means of sexual intercourse between the separate individuals. We can also make very similar observations regarding the species of *Hemiptychina* occurring in the Salt-range.

The genus *Hemiptychina* is rather largely represented in the different divisions of the Productus-limestone of the Salt-range, for not only are individuals belonging to the genus rather numerous, but they can also be referred to a number of species.

Five species of *Hemiptychina* are distinguishable among the specimens in the Salt-range collection. One of them has been long known to science, and was described by Davidson as *Terebratula himalayensis*. Two others are very nearly related to Davidson's species, and are chiefly distinguishable by less strongly developed folds. I shall call these two *Hem. sublaevis*, W., and *Hem. sparsiplicata*, W. Another species is easily recognisable by its very inflated valves, and will bear the name of *Hem. inflata*, W. The last species presents a great number of folds, and will therefore receive the name of *Hem. crebriplicata*, W.

The geological distribution of these species is unequal. The oldest of them is *Hem. sublaevis*, which occurs in the lower division of the Productus-limestone. The lowest beds of the middle division of the same formation are characterised by *Hem. sparsiplicata*, W., whilst in the upper region of the middle division and in the upper division of the Productus-limestone *Hem. himalayensis*, Dav. sp., occurs in great numbers. There are, it cannot be denied, some stragglers of the geologically older species sometimes also in more recent strata, but in general the appearance in time of the species is as I have indicated. The species mentioned are the three principal ones. They form in a very prominent manner a developmental series, which is characterised by the successive apparition of folds on the shell. Round this series the other species can be grouped—*Hem. inflata*, W.,

which is not rare in the upper region of the middle division, and in the upper division of the Productus-limestone, and *Ilem. crebriplicata*, W., which is restricted to the middle division of the same formation.

1. *HEMIPTYCHINA SUBLÆVIS*, Waagen. n. gen. et sp., Pl. XXVII, figs. 1, 2, 3.

The general form of this species is more or less ovoid, with strongly inflated valves, a thick well curved beak, with tolerably large foramen, and a vaulted frontal line, which is slightly indented only at the very margin of the valves, indicating a plication that is a very little more distinctly developed in a few specimens.

The ventral valve is very equally vaulted in both directions. The beak is thick, pierced well behind its apex by a tolerably large round foramen, from which a shallow channel extends down to the apex of the beak. The deltidium is large, excavated and limited on both sides by sharp carinae of the shell; generally, however, it is concealed by the overhanging part of the beak. The false area which extends on both sides below the beak is very broad, and not at all separated from the remainder of the shell.

The dorsal valve is generally a little less strongly vaulted than the ventral one, but the difference is very small, and applies only to the longitudinal bend, whilst in a transverse direction both valves are equally strongly inflated.

The margins of both valves are very little bent; they descend from the apex of the smaller valve in a slight curve towards the ventral valve, and ascend again in the frontal region to form a slightly vaulted frontal line. The lateral parts of the margins are smooth, but the frontal part is indented, forming more or less distinctly a zig-zag line. These indentations correspond in some specimens with indistinct short folds, which are however limited to the immediate vicinity of the margins themselves. These folds appear oftener on the ventral than on the dorsal valve. Their number is irregular, but there are seldom more than three folds or indentations on the dorsal, and four on the ventral valve. Very often there are only two indentations observable in the dorsal valve, and even these are sometimes so faintly expressed as to disappear almost entirely, and then the shell shows quite smooth margins of the valves all round, and only a slightly vaulted frontal line.

Of the internal character of this species nothing could be ascertained, except that in the ventral valve dental plates have not been observed up to the present, but that in the dorsal valve well developed septal plates exist, as is shown by a partial cast from Pail.

The substance of the shell is granulated, but this granulation is so extremely fine that it can only be seen with a magnifying power of 15 to 20 linear, whilst in other *Terebratulide* a power of 5 or 6 is sufficient to bring out the puncturing quite distinctly. The punctures are extremely close together, but do not show any kind of regular arrangement.

The measurements of two specimens from Amb are as follows : —

	I.	II.
Entire length of the shell	20 mm.	19 mm.
Length of the dorsal valve	17 "	16 "
Entire breadth of the shell	14 "	14 "
" thickness "	10 "	11 "
Apical angle of the larger valve	66°	70°
" " of the smaller "	101°	104°

The size indicated above is not the largest the species can attain, as a specimen from Pail attains a length of 23 mm.

Locality and geological position.—This species of the genus *Hemiptychina* is the prevailing one in the lower division of the Productus-limestone. Most of the specimens were collected by myself at Amb at two different horizons. Three of them were found by me in the lowest fossiliferous bed there, and ten more in the dark coloured sandstone called by me (in my note-book) "Chonetes-bed," which also belongs to the lower region of the lower division of the Productus-limestone. Three more specimens were collected by me at Pail in those rusty coloured sandy limestones, which have furnished so many *Fusulina* and *Spirifers*, which will be described later on in this work; these also form part of the lower division of the Productus-limestone.

In higher beds specimens very similar to the present species are sometimes met with, which should possibly be considered as belonging to it, as, for instance, in the lowest beds of the compact Productus-limestone of Katta; but they are all more inflated and show also on the lateral margins of their valves some indentations, and thus prove themselves to be truly intermediate forms between the present and the following species, in either of which they might be placed with equal right.

Remarks.—The peculiarities which characterise this species in particular, and which distinguish it well from other allied forms, consist in the small number of indentations of the margins of the valves, which are generally exclusively limited to the frontal part of the shell, and only exceptionally correspond to short folds near the margins of the valves. In *Hemiptychina himalayensis*, Dav., which is the most nearly related one of all the species hitherto described, the marginal folds are, according to Davidson's description, four or five in the frontal, and two or three more on each lateral part of the shell, and reach for the length of several millimeters up from the margins of the valve.

The specimens of *Hem. sublaevis* in which the indentations have been quite obliterated, and smooth margins of the valves thus produced, are not at all dissimilar to some of the species of *Terebratula* described by Hall out of the devonian strata of New-York, and I therefore consider it highly probable that the genus *Hemiptychina* is represented already in the devonian period.

2. *HEMITYCHINA SPARSPLICATA*, Waagen, n. gen. et sp., Pl. XXVII, figs. 4, 5, 6.

The general outline of this shell is shortly ovoid, with tolerably strongly inflated valves, small beak, and almost unvaulted frontline, which is composed of many zigzag bends. The valves are smooth until a short distance from the margin, where coarse plications appear, corresponding with the zigzag bends of the frontline.

The ventral valve is very equally vaulted in every direction. The beak is well bent over, not very thick, and pierced just behind its apex by a not very large round foramen. The triangular deltidium is well developed, excavated, but mostly concealed. The false area is tolerably, but not very, broad, very indistinct and not separated from the remainder of the shell. The valve is entirely smooth for about two-thirds of its length, and then a few coarse but not very prominent folds appear. There are generally two of them in the frontal region and two to three on each lateral part; the two median ones are a very little more prominent than the lateral folds. These folds reach down to the margins of the valve and cause there very strong indentations, which are never, as is mostly the case in the preceding species, limited to the frontal part, but always extend on to the lateral margins.

The dorsal valve is always as strongly vaulted as the ventral one, and its transverse curve is only very little stronger than the longitudinal one. In this valve the marginal plications begin to appear much later than in the ventral one, and about three-quarters of the entire length are entirely smooth, only showing some inconspicuous striae of growth. With the last quarter of the longitudinal extension of this valve, distant folds begin to appear, which rapidly increase in size and height as they approach the margin. The folds are situated at the interstices between the folds of the ventral valve, causing strong indentations at the valve's margin. There are in the dorsal valve three such folds in the frontal region, and two to three on each lateral part of the valve in full-grown specimens, whilst in smaller ones only one lateral fold is yet developed.

Of the internal characters of this species nothing could be observed, except that there exist no dental plates in the ventral valve. The granulation of the shell is, if possible, even yet finer and closer than in the preceding species.

The dimensions of three specimens from Katta are as follows:—

	I.	II.	III.
Entire length of the shell	18 mm.	17.5 mm.	16 mm.
Length of the smaller valve	16 "	15 "	14 "
Entire breadth of the shell	14.5 "	14 "	12 "
" thickness "	10 "	10 "	8.5 "
Apical angle of the larger valve	73°	76°	69°
" " of the smaller "	120°	123°	111°

Locality and geological position.—This species is not rare at certain localities of the Salt-range, but it appears that its more numerous occurrence is restricted to certain beds, which are very limited in their vertical extent, and always compose the lowest part of the middle division of the Productus-limestone.

The geologically oldest specimen of this species I collected at Amb together with many specimens of *Hem. sublaevis*, W., in the so-called *Chonetes*-bed of the lower division of the Productus-limestone.

More numerous specimens are met with, as soon as one enters the lowest beds of the compact limestones forming the middle division of the Productus-limestone. In this position I collected the species at Katta in a yellow marly limestone which I designated in my note-book as bed No. 12, and not less than 15 specimens of this species were collected by me in a few minutes. Three not very characteristic specimens, showing to some extent a transitional form between the present species and *Hem. sublaevis*, W., were collected by me in a similar geological position, but probably somewhat lower down, at Nursingpaluár, in a black sandy limestone, together with *Dielaema truncatum*, W. Another specimen I found at Amb, also in the lowest beds of the compact Productus-limestone.

There are in the Salt-range collection yet several more specimens of this species, which were collected by Dr. Oldham, and ten of which come from Swás, whilst others are from the Bazár Wán.

The species continues in some straggling specimens up into the upper beds of the middle division of the Productus-limestone, and possibly even sometimes into the upper division, but in these beds it is mostly replaced by *Hem. himalayensis*, Dav. sp. I collected the species in the upper region of the compact limestones at Katta where I obtained two specimens and one at Musakhyl.

Remarks.—This species is chiefly characterised by its large apical angle and its thus more or less roundish form, by its coarse and not numerous marginal folds, and its comparatively small beak. It shows, however, much variation in form and sculpture; and thus many transitions in shape to *Hem. sublaevis*, as well as to *Hem. himalayensis*, Dav., can be pointed out. Nevertheless, I thought it expedient to note the typical form by a special name, as it is very characteristic for certain beds; even if there were nothing but a number of *Hemiptychina*, one could tell, by noting the prevailing form among them, what beds they might come from, as, for instance, if the present species were found prevailing one might be sure that these shells came out of the lower region of the middle division of the Productus-limestone.

The characteristic features of this species given above are sufficient to distinguish it from the allied forms *Hem. sublaevis*, W., and *Hem. himalayensis*, Dav. sp.

3. HEMIPTYCHINA HIMALAYENSIS, Davidson, sp., Pl. XXVI, figs. 6, 7, 8, 9, 10.

1902. *Terebratula himalayensis*, Davidson : Quart. Jour. Geol. Soc., Lond., Vol. LVIII, p. 27, pl. II, fig. 1.

1863. *Terebratula himalayensis*, (Dav.) Konnck : Fossiles Paléozoïques de l'Inde, p. 32, pl. IX, fig. 1.

1878. *Terebratula himalayensis*, (Dav.) Wangen. : Rec. Geol. Surv. Ind., Vol. XI, p. 186.

The general outline of this shell is very variable, roundish ovoid, or elongated, with sharp margins, or, which is oftener the case, truncated at the front. At the margin there are twelve to fourteen short distinct folds; the frontline is on the whole nearly straight, the margin of the valves being, however, frequently indented strongly and frequently according to the folds. The beak is small and pierced just behind its apex by a not very large, sometimes round, sometimes oval foramen.

The ventral valve is generally not very strongly vaulted, and extends sometimes with a very equal curve from the beak to the frontline; but more often it is suddenly deflected not far from the margin and turned with a strong bend upwards. By this peculiarity the ventral valve appears much deeper and much more strongly inflated than it would be otherwise. The beak is well bent over; the foramen is just behind the very pointed apex, and mostly of a roundish form, with a canal extending from the lower margin of the foramen to the apex of the beaks. The deltidium is well developed, excavated for the reception of the apex of the smaller valve, but it is, for the most part, concealed by the overhanging part of the beak. The false area is generally not large and never marked off from the remainder of the shell by any kind of ridge or the like. This valve remains smooth for at least more than two-thirds of its entire length, and only then the plications appear. It is not quite easy to tell which of these plications belong to the frontal region, properly speaking, and which are on the lateral parts, as there exists no proper limit to the frontal part. One can, however, in general, say that there are on this valve at least five folds in the frontal region, whilst there are at least three more of them on each lateral part, so that, on the whole, there are eleven to twelve folds on this valve. When the shell suddenly turns up producing a truncation of the frontal region, this truncated part is covered with many regular, slightly imbricating striae of growth.

The dorsal valve is as much vaulted as the ventral one. The bend is in some cases quite regular, as in the specimen figured by Davidson; more frequently, however, the valve suddenly turns down vertically or even bends inside to meet the margin of the ventral valve. Generally this truncated part of the dorsal valve is smaller, less high, than that of the ventral one. The dorsal valve remains smooth for a longer distance than the ventral one, that is to say the plications appear later in the dorsal than in the ventral valve, and are therefore in the former more limited to the vicinity of the margins. There are in this valve four to five folds in the frontal region, and three more on each lateral part. In this valve also the truncated part of the shell is covered by many slightly imbricating striae of growth which form a zigzag line, as does the margin of the valve itself.

The internal characters of this species were very completely ascertained, but it was impossible to distinguish the muscular impressions in the ventral valve.

In the ventral valve the beak is perfectly hollow, without any partitions. At the foramen the margin of the shell is curved, so that the foramen is surrounded on its inner side by a tolerably high, sharp, shelly ring. At both sides of the deltidium the teeth begin as low ridges which extend on both sides along the hinge margins, increasing at the same time in height, and terminating with a prominent but not very high point. They are separated from the hinge-margin by a distinct furrow.

In the dorsal valve there is no very distinct cardinal process on the apex of the valve. The so-called hinge-plate is slit open in the middle up to the very apex; the middle parts, beginning from the dental sockets, are deflected and bent down, and are fixed as septal plates to the bottom of the valve. The dental sockets are on their inner side limited by high, sharp crests, which form one plane with the septal plates. These latter are cut out immediately below the dental sockets, but then again stretch far down the valve as low ridges, separating the muscular impressions. The crura take their origin just below where the dental sockets terminate as broad laminae, which get rapidly narrower, being narrowest at about one millimeter from their origin. Where the crura are narrowest, broad triangular spurs originate, which are bent somewhat inward towards the middle of the shell. From the spur the crura gradually taper again in breadth, and terminate after having reached a length about equal to that of the dental sockets. The transverse piece of the loop is attached at an acute angle to the crura; it is very narrow and well bent up towards the apex of the valve.

The muscular impression of the dorsal valve can be well seen. The anterior adductors have left large marks near and below the termination of the septal plates. They are of ovoid shape, pointed on the upper and broadly rounded on the lower side, and are placed obliquely so as to touch, in their lower part, nearly the middle line of the valve, whilst their pointed upper part is directed towards the lateral parts of the hinge-margin. The impressions of the posterior adductors are situated between and above those of the anterior ones, separated from the upper part of the latter by the last termination of the septal plates. They are enclosed between the septal plates, are very narrow and very elongated, reaching up to about the lower end of the dental sockets and are separated from each other by a raised middle line of the valve. Though the cardinal process is not strongly developed, yet the impressions of the cardinal muscles can be very well distinguished on it.

The substance of the shell is as finely granulated as that of the preceding two species.

The dimensions of three different varieties of this species, No. I from Swås No. II from Musakhey, and No. III from Khura, are as follows:—

	I.	II.	III.
Entire length of the shell	20 mm.	21 mm.	19.5 mm
Length of the smaller valve	18 "	18.5 "	16 "

	I.	II.	III
Entire breadth of the shell	16 mm.	14.5 mm.	17 mm.
" thickness "	11.5 "	13 "	8 "
Apical angle of the ventral valve	75°	67°	7°
dorsal			120°

The variety No. III is that figured by Davidson, only that his specimen was somewhat large, and measured as much as 23mm. in length.

Locality and geological position.—This species is very common in the Salt-range, though it is so only in certain beds. It begins already in the lower division of the Productus-limestone, and was collected by me in this position in the "*Chonetes*-bed" near Aumb, but I only got two specimens. In the lower part of the middle division of the Productus-limestone it also occurs, but is very rare. A single specimen, found by me at Katta in these beds, proves its existence there. The species attains chief development in the upper part of the middle division of the Productus-limestone, and most of the specimens that are preserved in the Salt-range collection come from these beds. I collected seventeen specimens of this species in these beds in the mountains east of Katwāhi in hard light-coloured limestone (silicified), five specimens at Katta in light-coloured silicious limestones, one at Khura in the section there in the top-most beds of the compact limestones, three on the road from Vurcha to Uchāli in light-coloured limestones, and two at Chidru in the top beds of the middle division of the Productus-limestone. This species has been collected by Dr. Oldham in hard light-coloured limestones at Swās (four specimens), at Morah (one specimen), and at Musakhēyl (seven silicified specimens). Mr. Wynne obtained one specimen from these beds at Vurcha.

In the trans-Indus continuation of the Salt-range the species was detected in the same geological position by Mr. Wynne at Kālabāgh in a grey limestone (three specimens silicified), and at Kafirkót by myself in a light-coloured silicious limestone (two specimens).

There are thus altogether in the Salt-range collection forty-seven specimens out of the upper region of the middle division of the Productus-limestone.

In the upper division of the Productus-limestone this species was found by myself at Jabi in the Cephalopoda-bed together with *Cyclolob. oldhami*, W. (four specimens silicified); at Chidru in the Cephalopoda-bed (five specimens), and in the beds above it (six specimens) by Mr. Wynne. This species was also found in this division at Khund Ghat, where Mr. Wynne obtained four specimens.

Remarks.—This species, as I had already occasion several times to remark in the description of it, is very variable in nearly all its characters, and it might thus appear inconsequent on my part were I to leave all these varieties under one specific designation. The truncated varieties, for instance, might well be considered as being different from the broad, flat, typical form as figured by Davidson; and also the more cylindrical shapes might be something different from the broadly rounded ones; but the specimens I have at present at my disposal are not sufficient to

settle these points satisfactorily. At present all these different forms seem to be linked together by such an overwhelming number of transitional forms that a further distinction seems at present absolutely impracticable.

The only character by which the species can always be recognised is the number of folds it possesses. By this character alone it is possible to distinguish it from the two previously described species. If one did not seize upon this character it would not be possible to separate even those two species from the present one. I cannot say why greater stress should be put on this character than on others; but the fact is that, in observing the number and development of the plications occurring on these shells, it is possible to tell very positively what horizon a number of *Hemiptychinae* collected in the Salt-range may have come from. Among a set of shells coming from the lower division of the Productus-limestone, there might be one or two specimens of the form of *Hem. himalayensis*, Dav., but the majority of specimens will always bear the characters of *Hem. sublania*, W. If, on the other hand, such a set of shells comes from the lower region of the middle division of the Productus-limestone, by far the majority of the forms will always exhibit the characters of *Hem. sparsiplicata*, W., though one or more specimens of the other two species may be among the lot. In the upper region of the middle division, and in the upper division of the Productus-limestones, the forms with numerous folds so far exceed in number the other two forms that the occurrence of the latter becomes quite unimportant.

This mode of occurrence is certainly worthy of notice and cannot be passed over in silence. It is most certain to be taken note of, if the three forms are distinguished as three distinct species, a mode of proceeding which I have adopted here.

Hemipt. himalayensis, Dav., sp., is not restricted to the Salt-range, but occurs also in the Himalaya, where it was collected by Mr. Hughes on the Milam Pass in a white compact limestone. In mentioning the occurrence of this species in the Rec. Geol. Surv. of India, Vol. XI, p. 186, I compared the bed in which the species there occurs to the "lower carboniferous limestone of the Salt-range." This I must correct now to a certain extent, as, at the time I wrote that note, I thought that the Productus-limestone of the Salt-range should properly be divided into only two divisions, to the lower of which the beds in Hundes would possibly have been parallel. Now, however, I can say more positively that it is very likely the middle division of the Productus-limestone with which the Hundes-beds may be compared. I am led to accept this opinion not only by the occurrence of *Hem. himalayensis*, but also by the presence of such species as *Ter. subvesicularis*, Dav., and by the fossil which I mentioned under the name of *Bactrynum* sp., and which will be described more accurately further on in this volume. All these forms are more or less characteristic of the compact limestones of the middle division of the Productus-limestone.

4. *HEMIPTYCHINA INFLATA*, Waagen, n. gen. et sp., Pl. XXVII, figs. 7, 8, 9.

The general form of this shell is more or less globular with extremely inflated valves, a not very large beak, and numerous and strong plications which cover about half the length of both valves.

The ventral valve is very differently curved according to the age and the inflation of the specimen. In moderately sized and not too strongly inflated specimens, the ventral valve is longitudinally and transversely very equally curved, forming in both directions nearly a semi-circle. In somewhat large and yet more strongly inflated specimens, however, the curve is only regular for about half the length of the valve, then a rather sudden deflection takes place, and the shell ascends more or less flatly to the frontal line. The beak is comparatively small, distinctly bent over, and pierced behind its apex by a not very large foramen. The false area is very oblique, not very broad, and not marked off from the remainder of the shell. The greater part of the ventral valve is covered by a strong radial plication, which commences not far from the beak and extends down to the frontal line. In other specimens, half the length of the ventral valve is smooth and the other half plicated. There are four to six folds in the frontal region, and generally three more on each lateral part. The folds are mostly simple, but sometimes one or the other is split up into two already from the beginning or, which is however very rarely the case, all the folds become bifid not far from the frontal line. The margin of the valve, forming a zigzag line, is generally not much produced in the frontal region, and accords with the slightly vaulted frontal line. The valve is ornamented by some conspicuous striae of growth, which are chiefly crowded together near the margin of the valve.

The dorsal valve is never so equally curved as the ventral one. In the longitudinal direction this valve is nearly flat for about half its length, then a more or less sudden deflection takes place, after which the valve descends either in a slightly broken or rounded curve to the frontal line, or the deflection is so strong, chiefly in the case of large and very strongly inflated specimens, that the shell bends over inward, and the valve then appears slightly shorter at the frontal line than at the place where it makes the bend. Also transversely this valve is not quite equally vaulted. In the apical region the lateral parts are slightly impressed, whilst further on towards the frontal part the transverse curvature gets more regular, until, in very strongly inflated specimens, the lateral parts also turn abruptly down to the margin of the valve. The plications begin in this valve later than in the ventral one, and at least half or more than half of the entire length of the valve is smooth. There are four to five folds on the frontal part of the valve, and four or five more on each lateral part. The margin of the valve is strongly indented where the folds reach it. There are many striae of growth crowded together along the margin.

Of the internal characters of the species, the loop could not be made visible; it could, however, be clearly ascertained that in the dorsal valve two very strong and very long septal plates existed, which approached each other very much, and extended from the apex of the valve to about one-third of the length of it in a nearly parallel direction, measuring 7 mm. in a specimen of 19 mm. total length, and being at their lower extremity 1.5 mm. apart from each other. In the ventral valve dental plates do not generally exist; there is one specimen, however, in one side of which a faint trace of a dental plate can be traced for some length, whilst on the other side not a trace of such a plate can be detected. (This is probably a case of hybridity with *Dielasma plicata*, W.)

The granulation of the shell is as fine as in the other species of *Hemiptychina*, and requires a very strong magnifying power to be at all detected.

The measurements of four specimens, Nos. I, III and IV from Morah, and No. II from Khura, are as follows:—

	I.	II.	III.	IV.
Entire length of the shell . . .	26 mm.	24 mm.	22 mm.	19 mm.
Length of the smaller valve . . .	21 "	20 "	18.5 "	16 "
Entire breadth of the shell . . .	20 "	18 "	17 "	15.5 "
" thickness " . . .	21 "	18 "	10.5 "	14 "
Apical angle of the larger valve . .	71°	65°	72°	73°
" " " " smaller " . . .	124°	118°	116°	112°

The specimen No. I is the largest and most inflated one known to me.

Locality and geological position.—The greatest number of specimens of this species were collected by Mr. Wynne at Morah in a light-coloured, compact limestone, forming beyond doubt part of the middle division of the Productus-limestone. There are not less than seventeen specimens from that locality. Another specimen was found, also by Mr. Wynne, at Musakheyi, in a reddish, compact limestone. By myself the species was found in the section near Khura in the top beds of the middle division of the Productus-limestone (two specimens), west of Khura in yellow, marly beds at the very base of the upper division of the Productus-limestone (one specimen), and in the mountains east of Katwáli in white limestones, low down in the middle division of the same formation (three small specimens).

Remarks.—This species shows but small variations, and even young specimens of it can easily be distinguished from *Hem. himalayensis*, Dav., by the very inflated condition of its valves and by its plications, which commence on the ventral valve, not far from the beak. Another species which is rather similar to the present one is *Dielasma plicata*, W. This can be distinguished from *Hem. inflata*, W., by its less numerous plications, and the very distinct dental plates, which can generally be made easily visible. I have already mentioned above that in one specimen of the present species rudimentary dental plates, or at least one such plate, occurs. I am inclined to consider this anomaly as the result of hybridity between *Dielasma*

plicata and *Hemiptychina inflata*, as both species are contemporaneous and occur in the same beds.

Among the species occurring in Europe *Hemiptychina renierii*, Cat., from liassic beds of the Alps, can preferably be compared with the species under consideration. I have already stated above the reasons why this species would be considered as a *Hemiptychina*. From our *Hem. inflata* it can be distinguished by its much heavier shell, thicker and less curved beak, with its very large foramen, by the more circular shape and less strongly inflated valves.

5. *Hemiptychina crebriplicata*, Waagen, n. gen. et sp., Pl. XXVII, fig. 11.

The general outline of this species is roundish ovoid, not much longer than it is broad, with slightly inflated valves, a straight indented front line and tolerably small beak.

The ventral valve is not strongly, but very equally, vaulted in every direction. The beak is not very thick, well bent over, and pierced just behind its apex by a not very long, round foramen. The false area is rather narrow and not marked off from the remainder of the shell. The valve is smooth for a little more than half its length, then a number of folds begin to appear, which soon become very distinct and reach down to the margin of the valve. There are seven folds in the frontal region, of which the middle one is distinctly stronger than the others. On each lateral part there are five folds more, so that this valve bears altogether not less than seventeen folds, of which the two last lateral ones are however rather indistinct. The margin of the valve is finely indented, where the folds reach it. Striae of growth cannot be detected on the valve.

The dorsal valve is not as equally vaulted as the ventral one. In the longitudinal direction it is tolerably flat for about two-thirds of its length, but from there it bends more rapidly down to the margin. Transversely the curve is rather regular. The flat part of the valve is perfectly smooth, and it is only where the shell bends down that the plication begins to appear. There are six folds in the frontal region, separated from each other by furrows, which are about as broad as the folds themselves. Only the middle furrow is broader and deeper, corresponding to the more prominent median fold on the ventral valve. On the lateral parts there are six folds on each side, so that the valve altogether bears eighteen folds, of which however the two last lateral ones are rather indistinct. Striae of growth are absent.

The granulation of the shell is as fine as in the other species of *Hemiptychina*.

Of internal characters only the existence of two strongly developed septal plates can be observed. The plates are tolerably long and rather far apart from each other. In a specimen 21 mm. in length they are 6 mm. long, and at their lower extremity 3 mm. apart. In the ventral valve dental plates are decidedly absent.

The measurements of a specimen from Morah are as follows :—

Entire length of the shell	20 mm.
Length of the smaller valve	18 "
Entire breadth of the shell	17 "
" thickness " "	11 "
Apical angle of the larger valve	80°
" " " " smaller "	115°

Locality and geological position.—There are altogether three specimens of this species preserved in the Salt-range collection, which were all found by Mr. Wynne. Two of them are from Morah out of white limestones forming part of the middle division of the Productus-limestone; the third specimen is from Kálabágh hill on the western shore of the river Indus, out of marly calcareous beds, also belonging to the middle division of the Productus-limestone.

Remarks.—This species is more or less nearly related to most of the species of *Hemiptychina* described on the foregoing pages, but it can easily be distinguished from all of them by its less inflated valves and by the far finer plication of its shell. There has been, as far as I am aware of, no shell described from any not Indian locality which would compare more particularly with the present species.

Subfamily: *CENTRONELLINÆ* (?)

GENUS: *NOTOTHYRIS*, Waagen, n. gen.

In the introduction to the family *Terebratulidæ* I have already mentioned the existence of a genus in the Salt-range, which probably could be considered as belonging to the subfamily *Centronellinæ*.

According to the divisions of the *Terebratulidæ* introduced by Von Buch and Quenstedt the species belonging to this genus would have to be considered as forming part of the *Antiplicata*, as there is mostly a considerable sinus in the dorsal valve and a corresponding vault in the frontal line of the ventral valve, so that the general curvature of the frontal line is in an opposite sense to that prevailing in the *bipllicate Terebratulæ*. The internal characters of these shells are, however, much more strange than their external shape.

In the ventral valve the hinge is composed of two strong, short teeth, which are rather far distant from the deltidium. The space between the latter and the teeth is occupied by the sharp hinge margin. The deltidium is generally not large but distinct, but whether it was composed of two pieces or not is uncertain. The beak is thick and strongly bent over, but not very long, pierced by a large oval foramen. At the margin of the foramen the shell bends inward and surrounds it on the inner side by a distinct, sharp and high shelly ridge. Dental plates are entirely absent. The muscular and other impressions cannot be distinguished in the ventral valve.

In the dorsal valve the apex bears no distinct cardinal process. From both sides of the apex high, sharp ridges start, which are separated from the hinge margin by a furrow which widens near the extremity of the ridges into a roundish groove for

the reception of the teeth of the ventral valve. Between these two ridges, at their base, a perfectly level, shelly plate extends down to the end of the sockets, filling the triangular space between the apex and the extremities of the two ridges. At the place where this plate is joined to the sloping inner walls of the ridges mentioned above a shallow furrow extends. The most remarkable feature, however, is, that this plate is pierced just in front of the apex by a tolerably large, elongately oval, or slightly triangular foramen. At its lower extremity the plate is limited by a straight, slightly thickened and somewhat raised margin. The crura are fastened to the underside of this plate, at the place which is marked on the upper side by furrows, and where this hinge plate is joined to the socket walls. The crura begin already at the apex and extend on the underside of the hinge plate as divergent, not very far projecting sharp ridges, which never reach down to the bottom of the valve to form what in other genera I called septal plates. Where the hinge plate terminates with its thickened margin, the crura make their appearance from under it, and quickly extend into broad, shelly lamellæ, bearing on their upper margins a high sharp spur. The spurs of both crura are rather far distant from each other. The crura are very strongly curved in the horizontal plane of the valve, but not in a vertical direction. In front of the spurs they get again narrow and extend down more than half (0.6) of the entire length of the valve. Though I took very great pains, and sacrificed nearly a dozen specimens belonging to this genus, I never was able to detect a transverse shelly band connecting the two lower extremities of the crura, and I am almost inclined to think that the loop was not complete, that is to say, that it was only partly calcified.

The impressions of the muscles are also very strange, though very imperfectly known to me. In the ventral valve nothing at all could be seen, but in the dorsal valve there are two very large adductor impressions at the sides of a slightly raised, somewhat broadened and flattened median line, and separated from the latter by small sharp lines. They are of a broadly oval form, but seem to be single, as up to the present not a trace of a second pair of adductors could be detected.

This is all that I could ascertain of the interior characters of this genus. There is no doubt that shells bearing so strange internal appendages should be considered as forming a separate genus, distinct from *Terebratula* and the other genera that have been described up to the present; but it is extremely difficult to find out the relations in which this genus stands to the other *Terebratulidæ*. That the genus forms part of the large family *Terebratulidæ* is demonstrated as well by the absence of spirally coiled appendages, as by the structure of the shell, which is very distinctly, though very minutely punctate. Its punctation is about as minute as in *Hemiplychina* (see *ante*). But beyond this no certainty whatever exists. The peculiarity of an internal foramen in the dorsal valve is, as far as I know, only repeated in a certain group of species of *Athyris*, or even in all the forms belonging to that genus, but beyond this there exists no analogy between *Athyris* and the present genus. I have thought it expedient to bring *Notothyris* into a certain relation to *Centronella*, as possibly belonging to the same subfamily, though I have

not any imperative reasons for doing so. In *Centronella*, as well as in *Notothyris*, the middle part of the frontline is depressed, whereby the two genera have to be considered as belonging to the *Antiplicatæ*. The transverse piece of the loop of *Notothyris* is unknown up to the present, and it is not impossible that this part of the loop was never calcified, but was replaced by soft fleshy parts. The curvature of the crura, as far as they have been observed, is similar in both genera. In *Centronella* also the loop is perfectly free and no septal plates exist, and the cardinal process is as little developed as it is in *Notothyris*. These are at least some analogies, and, as the present genus shows even fewer analogies with the other groups of *Terebratulidæ*, it will be best to place it in a provisional way into the subfamily *Centronellinæ*.

The genus has, as far as is known up to the present, a purely eastern distribution, and is found most numerous in the palæozoic deposits of India, where it occurs in tolerably large numbers in the Salt-range, and, more rarely, in the Himalayas. One species has been described by Abich also from Djulfa on the Araxes.

In the Productus-limestone of the Salt-range there are not less than seven species, which range through the middle and upper divisions of the formation. The geologically oldest species was found by myself at Katta in the lowest beds of the compact Productus-limestone. It is a very small species and will receive the name of *Notothyris simplex*, W. In the middle and upper region of the middle division no less than six species have been met with. They are *Notothyris multiplicata*, W., *Not. minuta*, W., *Not. djoulfensis*, Abich sp., *Not. subcesicularis*, Dav. sp., *Not. inflata*, W., and *Not. warthi*, W. The latter species also ranges up into the upper division of the Productus-limestone, and is there the only representant of the genus, excepting some few specimens of *Not. subcesicularis*, and *Not. lenticularis*, W., which will also be described later on.

The occurrence of *Not. djoulfensis* in the Salt-range is of some interest. The identification of the Salt-range specimens with the Armenian species, will, I think, be found correct, though the figures given on Pl. XXVIII do not look quite as if they were identical with Abich's figure; but there are specimens in the Salt-range which on the one hand cannot be distinguished from Abich's figure, and on the other hand belong unquestionably to the same species as those specimens figured by me on Pl. XXVIII. The interior of the original specimens of *Ter. djoulfensis* is not known, and it is only by the analogy of the external form, and the ascertained internal characters of the Salt-range specimens that I place this form in the genus *Notothyris*. *Not. djoulfensis* is derived from beds which have been ascertained by Prof. v. Möller to be of lower permian age.

Though all the species of this genus which have been found in the Salt-range occur more or less in successive strata, yet no distinct law of development can be made out among them. It is true that the geologically older species are mostly smaller in size than the more recent ones, though none of these species attain considerable dimensions, but at the same time small and larger species appear promiscuously in the fossiliferous beds of Musakheyl, belonging to the upper region of the middle division of the Productus-limestone.

1. *NOTOTHYRIS SUBVESICULARIS*, Davidson, sp., Pl. XXVIII, figs. 3, 4.1862. *Terebratulula subvesicularis*, Davidson : Quart. Jour. Geol. Soc. Lond., Vol. XVIII, p. 27, pl. II, fig. 4.1863. *Terebratulula subvesicularis*, (Dav.) Konieck : Foss. Paléoz. de l'Inde, p. 82, pl. IX, fig. 4.

The general outline of this shell is broadly oval or slightly pentagonal, with, as a rule, moderately inflated valves, a small beak and only one median fold in the sinus of the smaller valve.

The ventral valve is slightly more strongly vaulted than the dorsal one. Its curvature is very equal, longitudinally as well as transversely. The beak is rather thin, short, not prominent, pierced at its apex or just behind it by a small round or slightly triangular foramen. Below these extends a small triangular deltidium, which is mostly visible, as the beak is not firmly adpressed to the apex of the smaller valve. The margins of the ventral valve are smooth for a certain distance from both sides of the deltidium, but then they begin to be cut out into a zigzag line having two to three indentations on each lateral part. In the frontal part a very distinct sinuation of the margin of this valve takes place, which forms a W-shaped line. The valve is smooth for about half its extent, beginning from the beak, and then strong folds appear which are not sharp but well rounded, and reach down to the margin of the shell. There are altogether six to eight folds, of which two, the two strongest ones, are on the frontal, and two to three on each lateral part.

The dorsal valve is not quite so strongly vaulted as the ventral one, and its curvature is generally not quite equal. It is somewhat flattened in the apical region, and then bends down more suddenly to the margin where the folds appear. For nearly two-thirds of its whole length, beginning from the apex, it is smooth, and only in the last third of its whole extent do strong, short folds make their appearance and reach down to the margin. The latter is produced in the frontal region, forming a tolerably broad W-shaped process. There are generally altogether five to seven folds on this valve, of which three are on the frontal, and one or two on each lateral part of the valve.

The internal arrangement of this species is as described in the character of the genus, specimens of this species having chiefly served in the delineation of this characteristic.

The structure of the shell can only be seen in one specimen, where it can be ascertained that the shell is distinctly punctate. The punctation is, however, not very fine, much coarser than, for instance, in *Hemiptyolina*.

The dimensions of three specimens from Musakheyl are as follows:—

	I.	II.	III.
Entire length of the shell	13 mm.	13 mm.	12 mm.
Length of the dorsal valve	11 "	10 "	10 "
Entire breadth of the shell	11.5 "	10.5 "	9.5 "
" thickness "	8.5 "	9 "	8.5 "
Apical angle of the ventral valve	91°	80°	80°
" " of the dorsal "	117°	117°	123°

Locality and geological position.—This species is not at all rare in the Salt-range, and there were not less than 20 specimens of it in the collection, of which, however, four have been destroyed in trying to ascertain their internal characters. Of these 20 specimens all but two came from the upper region of the middle division of the Productus-limestone. In this latter position the species was found by Dr. Oldham, Dr. Warth, Mr. Wynne and by myself at Musakhely (eleven specimens); by Dr. Oldham at Swás (two specimens); by myself at Khura (two specimens); and on the road from Vurcha to Ucháli (one specimen). In the Trans-Indus continuation of the Salt-range the species was met with in the same geological position by myself at Káfir-kót (one specimen), and by Mr. Wynne in the Paránga Kas (one specimen).

A single specimen was collected by myself in the upper division of the Productus-limestone at Chidru in the *Cephalopoda* bed, in which *Xenodiscus carbonarius*, W., was also found. I detected another specimen at the base of the upper division of the Productus-limestone in a section west of Khura.

Remarks.—This species was excellently described and figured by Mr Davidson, whose materials all came from Musakhely, where, beyond doubt, the species is most common, though it is not the only *Notothyris* which occurs at that locality. Nevertheless the species is easy to distinguish from its congeners by its small beak and by the number of its marginal plications, which is never more than three on the frontal region of the dorsal valve.

The species has been rightly compared by Davidson to *Terebr. vesicularis*, Kon., to which it has really a great similarity. A very fundamental difference, however, exists in the entire absence of lateral plications in de Koninck's species, and this difference is yet more manifest if we compare the internal arrangement of the mountain-limestone species (which seems to agree in all respects with that of the *Diclasma* in general) to that of our Indian shell, which in all respects differs widely from King's genus.

A certain similarity to *Hemiptychina himalayensis* exists also, and in some cases it becomes even difficult to distinguish between the two species; but there is in *Hemiptychina* always a certain tendency to form a slightly vaulted frontal line, whilst in *Notothyris*, on the contrary, the tendency prevails to bend the frontal line in the opposite direction, and only in very few specimens can one be in doubt if this character be properly taken heed of.

The species can be considered as characteristic of the upper region of the middle division of the Productus-limestone, as specimens in other geological positions are extremely rare.

2. NOTOTHYRIS DJOULFENSIS, Abich, sp., Pl. XXVIII, figs. 5, 6.

1878. *Terebratulula djoulfensis*, Abich Geologische Forschungen in den Kaukasischen Ländern, I, p. 68. pl. 6 fig. 10.

1879. *Terebratulula djoulfensis* (Abich) Möller Neu. Jahrb. f. Min., etc, page 228

The general outline of this species is elongately oval or slightly pentagonal

with a moderately large beak, and valves that are generally pretty strongly inflated, and bear only near their margins more or less strong plications, which are always more numerous than in *Nat. subovesicularis*, Dav.

The ventral valve is very generally more strongly inflated than the dorsal one, and bears mostly a very equal curvature, so that transversely as well as longitudinally the curvature is about equally strong. Only in some specimens, a sudden bend in this valve appears at the place where the marginal plications commence. The outline of this valve coincides with the outline of the whole shell, and thus, if this valve is more elongately oval, the form of the whole shell is also such; but when this valve is more broadly rounded, and at the same time strongly inflated, a nearly globular shape of the whole shell results. The beak is tolerably thin, not very prominent, but strongly bent over. It is pierced just behind its apex by a not very large oval foramen. The valve is smooth for about half its length from the beak, then there appear tolerably strong, rounded folds, which extend down to the margin of the valve. This latter is distinctly sinuated in the frontal region, so that the indentations corresponding to the folds of the frontal region are situated at a lower level than those of the lateral parts. There are very constantly nine folds on this valve, only in one specimen there are indications of one more fold on each side. Of these folds three are always in the frontal region of the valve, whilst the other six are distributed on both lateral parts.

The dorsal valve is always less strongly vaulted than the ventral one; the difference is, however, in some cases more considerable than in others; but the dorsal valve never becomes quite flat, it being always more or less strongly curved. This curvature is generally only transversely quite regular, but in the longitudinal direction this valve is mostly rather suddenly deflected where the folds commence. The folds are shorter in this valve than in the other one, and two-thirds or even three-quarters of the entire length of the valve remain smooth. There are generally ten folds on this valve, of which four are situated on the frontal part, whose margin is slightly prolonged, corresponding to the sinuation of the ventral valve, and three others are on the lateral parts. Both valves have in this species the peculiarity that in more strongly inflated specimens near the margins a great many imbricating striae of growth are crowded together, whilst in other specimens these striae of growth are absent (as, for instance, in the specimen figured by Abich, and also in several of the Salt-range specimens).

Of the internal arrangement of this species only the hinge-plate of the dorsal valve with its large oval foramen near the apex could be observed; the descending branches of the crura were only very rudimentarily exhibited in all the specimens I could spare for the investigation of the internal characters. In the ventral valve the absence of dental plates could also be observed.

The punctuation of the shell, which is very well observable in several specimens, is much finer than in the preceding species, nearly as fine as in the genus *Heimptychina*.

The measurements of three specimens, Nos. 1, and III, from Musakheyl, and No. II, from Swás, are as follows :—

	I	II	III
Entire length of the shell . . .	16 mm	16 mm	15.5 mm
Length of the smaller valve . . .	14 ..	14 ..	14 ..
Entire breadth of the shell . . .	14 ..	13 ..	12.6 ..
" thickness " " " . . .	12 ..	11 ..	12 ..
Apical angle of the larger valve . . .	80°	76°	70°
" " " smaller " " . . .	114°	112°	108°

Locality and geological position.—Of this species, which is somewhat less common than the preceding one, there are altogether ten specimens preserved in the Salt-range collection, all derived from the middle division of the Productus-limestone. This species again is most common at Musakheyl, where it has been collected by Dr. Oldham and Dr. Warth (six specimens). Another specimen was also found by Dr. Oldham at Swás. Mr. Wynne brought the species from Budikheyl (one specimen) and from Kálabágh, Trans-Indus (one specimen). I myself collected this species west of Khura, in beds which were just at the limit between the middle and upper divisions of the Productus-limestone (one specimen).

Remarks.—The identification of the Salt-range specimens with Abich's species does not seem to be in any way doubtful, judging at least by the excellent figure of the species given by Abich. Why his species should not be considered as established, and should be altogether excluded from the list of fossils occurring at Djoulfa, as Prof. v. Moller proposes, I cannot conceive. If the materials for this species, collected by Staatsrath Abich at Djoulfa were not very extensive, the specimen figured by him was beyond doubt excellently preserved, and certainly the species can very well be recognised from it. The occurrence of this form at Djoulfa is not the less interesting, if only a few or even only one well-preserved specimen were found.

The species is very nearly related to *Notothyris subresicularis*, Dav., but can easily be distinguished by the four folds on the frontal region of the dorsal valve, which is a very constant character of this species, whilst in Davidson's species very constantly only three folds appear on this part of the shell. Abich compares his species rather more to *Hemiptychima himalayensis*, Dav., than to *Not. subresicularis*.

It must be remarked, that Abich's description of the species is not quite in accordance with the figure on Pl. 6 of the work; and it appears from this description not quite improbable that among the materials which served for the establishing of his species there were really one or more specimens of *Hemiptychima*, leading to the description of several characters which exist in *Hemiptychima*, but not in *Notothyris*. It cannot however be considered in any way as a fault on the part of Mr. Abich, that such a confusion of species should occur, as only a scanty supply of these forms was available, it was absolutely impossible to distinguish between these shells, and it was only natural that all were considered as belonging to one and the same species. The figure unquestionably represents a shell belonging to the genus *Notothyris* and identical with the Indian fossils here described. That the figure on Abich's plate is quite correct I can vouch for, as the plates for Abich's

work were executed by the artist who has drawn the plates for the present work, and I am thus perfectly able to judge of the exactitude of his work.

It cannot be denied that a certain similarity exists also between *Not. djoulfensis*, Ab., and *Hemiptychina himalayensis*, but the two species can always be easily distinguished if one observes the configuration of the frontal line. It is vaulted, with a bend towards the dorsal valve, in *Hemiptychina*, and curved in an opposite direction, with a bend towards the ventral valve, in *Notothyris*.

Notothyris djoulfensis was described originally by Abich from Djoulfa on the Araxes in Armenia. The beds in which the species occurred were considered by him as forming part of the carboniferous formation, but were afterwards recognised by Moller as being of permian age. They are of special interest on account of their containing species of *Cephalopoda* that are generically identical with those of the "Buntsandstein" of the Himalayas, described by Griesbach under the name of *Otoceras moulinardi*.

3. NOTOTHYRIS WARTHI, Waagen, n. gen. et sp., Pl. XXVIII, fig. 1.

The general outline of this species is slightly pentagonal, somewhat longer than it is broad, with a very thick, overhanging but not adpressed beak, and very strong radial folds which commence not far from the apex of the valves.

The ventral valve is not very strongly inflated and its curve not quite equable. It is very strongly arched in the region of the beak, but gets much flatter towards the frontal part. The beak is, as indicated above, very thick, long and strongly overhanging, but quite distant from the apex of the smaller valve, so that below it a large triangular deltidium can be seen, which seems to be made up of two pieces. The false area is very broad and rounded, and extends from both sides of the deltidium and foramen nearly half-way down the length of the shell. The foramen is properly speaking roundish, and pierces the beak far behind its apex. From the foramen, however, there extends an open canal down to the apex of the beak, and this makes the foramen appear of a very elongated oval shape. This valve is smooth just for one-third of its entire length, beginning from the apex of the beak. Then very strong and rather sharp folds appear, which are very generally not more than six in number; only very rarely two additional very small lateral folds occur. Of these folds only two belong to the frontal region, and two on each side are on the lateral parts. As in other species of *Notothyris*, so in this one the margin of the ventral valve is cut out in the frontal region, and the indentations caused by the two frontal folds make the frontal margin appear of a distinctly W-shape, as in *Notothyris subvesicularis*, Dav. The whole valve is covered by numerous striae of growth, which are, however, not very distinct on the greater part of the valve, and become only conspicuous near the margin, where several successive, strong, imbricating striae of growth can be observed.

The dorsal valve is nearly regularly pentagonal in shape, and is not quite as

strongly inflated as the ventral one. Its curve is not quite regular, but it is somewhat flattened from the apex down to the beginning of the marginal folds, and then more or less suddenly bends down to the margin. This valve remains smooth over a rather larger area than the ventral one, though the smooth part occupies here also not quite one-half (exactly $\frac{2}{3}$) of the whole length of the valve. The folds then begin gradually but soon attain a considerable height and strength. There are seven folds on this valve, of which three are on the frontal, and two on each lateral, part. The folds are, however, very unequal in size. The two largest and most prominent folds are the two external ones on the frontal region, whilst the median one, as well as the folds on the lateral parts, are much less strongly developed. The margin of the dorsal valve is also somewhat produced in the frontal region to meet the sinuation of the margin of the ventral valve.

Of the internal characters nothing could be observed, but from the external form it is almost certain that the internal characters are those generally occurring in the genus *Notothyris*.

The substance of the shell is very distinctly but very finely granulated.

The measurements of two specimens, No. 1, from Jabi, and No. 2, from Musakheyl are as follows:—

	I.	II
Entire length of the shell	15 mm	13.5 mm
Length of the dorsal valve	12 "	11 "
Entire breadth of the shell	12 "	11 "
" thickness "	10 "	8.5 "
Apical angle of the larger valve	60°	60°
" " " smaller "	122°	117°

The specimen No. 1 is the largest that has been found up to the present

Locality and geological position.—This species is equally common in the middle division of the Productus-limestone as in the upper division. There are altogether eighteen specimens preserved in the Salt-range collection, of which eight are from the middle division, and ten from the upper division of the Productus-limestone. In the former geological position the species was found by myself at Káfir-kót (Trans-Indus) (five specimens), by Dr Oldham at Swás (one specimen), by Mr. Wynne at Kálábágh (Trans-Indus) (one specimen), and by Dr Warth at Musakheyl (one specimen).

In the upper division of the Productus-limestone the species was collected by myself at Jabi in the *Cephalopoda* bed together with *Cyclotobus oldhami* (eight specimens) at Chudru, also in the *Cephalopoda* bed, together with *Xenodius carbonarius* (one specimen), and by Mr Wynne at Khund Ghat (one specimen).

Remarks.—This species is rather nearly related to *Notothyris subresicularis*, Dav. sp., but can be well distinguished from that shell by the length and size of its beak and its much stronger and less numerous folds which commence already at a much earlier stage of growth. The same characters also distinguish this species from *Notothyris djoulfensis*, Ab.

From other non-Indian localities no species is known to me which could be in any way compared to the present one.

4. *NOTOTHYRIS INFLATA*, Waagen, n. gen. et sp., Pl. XXVIII, fig. 2.

The general outline of this shell is very difficult to define. It is not globular, though the thickness is nearly equal to the length of the shell. It is more or less irregularly polygonal, or, seen in the dorsal aspect, it is elongately oval. The beak is thick and large, strongly bent over and firmly adpressed to the apex of the dorsal valve. Both valves are so strongly inflated that they are quite out of shape. They are covered all over by strongly imbricating very conspicuous striae of growth and bear a few slightly developed folds near their margins.

The ventral valve would be hemispherical if the general outline of its margin were circular; but, as this forms an elongated oval, the form cannot exactly be called hemispherical, though it approaches more or less that shape. Its curve is, however, only tolerably equal in a transverse direction, longitudinally its curve is rather flat for about half the length of the valve, beginning from the beak, and then it descends in a nearly parabolic curve to the frontal margin. The margin is strongly indented, having two strong indentations in the frontal region, and one smaller one on each lateral margin. With these indentations folds correspond, commencing about in the middle of the length of the whole valve, and reaching down to the margin. There are four such folds on this valve, of which the two middle ones are the strongest, and are situated on the frontal part of the valve. Where the folds commence the strong imbricating striae or folds of growth commence also, and get more and more numerous the nearer the margin of the valve is approached. The beak is thick and overhanging, pierced behind its apex by a tolerably large, oval foramen. The false area is very sloping and not marked off from the remainder of the shell. The deltidium cannot be observed.

The dorsal valve is hardly less strongly inflated than the ventral one, though its inflation is of another kind. This valve is tolerably flat, but little curved down to where the marginal folds commence, which is at about two-thirds of its entire length. Then it suddenly bends very strongly down and even inwards, so that the margin of the valve lies at the same distance from the apex as the place where the marginal folds commence. The folds are five in number on this valve, of which three are in the frontal region and one on each lateral part of the valve. These folds are all very slightly developed and can barely be distinguished among the exceedingly strongly developed imbricating striae of growth, which cover all the parts of the valve from where the marginal folds commence. They are more numerous near the margin of the valve than further up.

Of the internal characters of this species nothing could be ascertained.

The substance of the shell is as finely punctate in this species as in the preceding one.

The measurements of a specimen from Musakhcyl are as follows:—

Entire length of the shell	14 mm
Length of the dorsal valve	10.5 "
Entire thickness of the shell	11.5 "
" breadth	10 "
Apical angle of the ventral valve	75°
" " " " dorsal	116°

Locality and geological position.—Only one specimen of this species is preserved in the Salt-range collection. It was found by Mr. Theobald at Musakhoyl, in the upper region of the middle division of the Productus-limestone.

Remarks.—Though only one specimen of this species is known, yet the general form of it is so singular and widely different from the form of other species that I consider it tolerably certain that the existence of a distinct species is indicated by the specimen. Its peculiarities consist in the great inflation of the valves, the extreme development of imbricating striae of growth, and the small number of marginal folds, which are less numerous and less strongly developed than in any of the preceding species.

5. NOTOTHYRIS LENTICULARIS, Waagen, n. gen. et sp., Pl. XXX, figs. 13, 14.

The general outline of this species is broadly pentagonal, about as long as it is broad. The valves are flat and not inflated, the beak small and pointed, there are a few marginal folds, which are, however, restricted to the very margin of the valves. As in other species of *Notothyris*, so also in this the dorsal valve shows a slight depression in the frontal region.

The ventral valve is regularly, but not strongly vaulted; its curve is, however, somewhat stronger in the region of the beak than towards the front. The beak is thin, strongly bent over, and pierced behind its apex by a very small slightly elongated foramen. The false area is small, not marked off from the remainder of the shell, and does not extend far down to the lateral parts of the valve. The valve is entirely smooth for $\frac{5}{11}$ ths of its length, then low and not very conspicuous folds appear, which reach down to the margin of the valve and are always nine in number, three in the frontal region and three more on each lateral part. Striae of growth cannot be observed on any of the specimens at my disposal.

The dorsal valve is slightly flatter than the ventral one. It is nearly circular or obtusely pentagonal in its outline, and entirely smooth down to near its very margin; the smooth space measured occupies $\frac{7}{11}$ ths of the entire length of the valve. The folds are here mere undulations of the margin, there are altogether eight folds present, four in the frontal region, and two on each lateral part. The frontal part of this valve is very little but always and perceptibly depressed.

Of the internal characters of this species nothing could be ascertained. The punctuation of the shell-substance is very striking and easily visible; it is very close, but apparently not so fine as in other species of *Notothyris*.

The measurements of a specimen from Khura are as follows:—

Entire length of the shell	. . . . .	15 mm.
Length of the smaller valve	. . . . .	13 "
Entire breadth of the shell	. . . . .	14.5 "
" thickness "	. . . . .	8 "
Apical angle of the ventral valve	. . . . .	88°
" " dorsal "	. . . . .	128°

Locality and geological position.—This species has been found up to the present only at a single locality. This was in the section west of Khura in thin bedded grey limestones at the limit between the middle and upper divisions of the *Productus*-limestone. The three specimens coming from that locality were collected by myself.

Remarks.—By the number of folds in the frontal region this species appears to be most nearly related to *Notothyris djoulfensis*, Ab.; it can, however, easily be distinguished from that species by its much broader and much flatter form, which is very conspicuous, and by the much less strong development of the folds, which are more strictly limited to the marginal region of the valves. By the same characters, as well as by the greater number of folds in the frontal region, the species may also be distinguished from *Notothyris subnucularis*, Dav., which appears to be also more or less similar to the present species. Much more strikingly different from *Notothyris lenticularis* are *Not. warthi*, W., and *Not. inflata*, W., and the former species cannot easily be mistaken for one of the other two. Thus *Not. lenticularis* appears to be a well defined species, which is sufficiently distinct from the other species of the same genus to be always easily recognised.

6. *NOTOTHYRIS MINUTA*, Waagen, n. gen. et sp., Pl. XXVIII, figs 7, 8.

The general outline of this species is roundish, thick, lenticular or nearly globular, with a proportionate beak, and plicated valves, which are smooth only in the apical region. The dimensions of the species are always very small, the largest specimen not attaining more than 10 mm. in length. The ventral valve is generally rather strongly vaulted, though its curve is often not quite regular, as in many specimens this valve experiences a sudden bend soon after the marginal folds have appeared. In other specimens again the curve of this valve is more regular, but then at the same time the valve is generally also less strongly inflated. The beak is comparatively rather small, not long and not firmly adpressed to the apex of the smaller valve. It is pierced behind its apex by a roundish not very large foramen. The deltidium cannot be made out in any of the specimens. The false area is rather broad, not marked off from the remainder of the shell, and reaching laterally more or less far down. The valve is smooth for one-third of its entire length, beginning from the beak. Then strong sharp folds appear, which reach down to the margin of the valve, and are generally seven in number—two are on the frontal, and three on each lateral part.

The dorsal valve is always less strongly vaulted than the ventral one. Its curve is mostly regular, only sometimes a sudden bend appears at the place where the marginal folds commence. The valve is smooth for just half its entire length. Then very strong and sharp folds appear, which reach down to the margin of the valve. There are nine such folds on this valve, of which three are in the frontal region and three on each lateral part. The median part of the frontal region is distinctly depressed, and the median fold on a lower level than the two external

ones, a peculiarity which is not well expressed in the figures, pl. XXVIII. The frontal margin forms thus very distinctly a W-shaped line.

Of the internal characters of this species nothing could be ascertained. The punctuation of the shell is well preserved in some specimens, but it is so extremely fine that even with a powerful lens it can only be distinguished with difficulty.

The measurements of two specimens, No. I from the Chittawán, and No. 11 from Morah, are as follows:—

	I.	II
Entire length of the shell	9 mm	7.5 mm
Length of the dorsal valve	8 ..	7 ..
Entire breadth of the shell	8 ..	6.5 ..
.. thickness	6 ..	5 ..
Apical angle of the ventral valve	81°	71°
.. .. dorsal	119°	114°

Locality and geological position.—This species is not rare in the middle division of the Productus-limestone. There are altogether eleven specimens of it preserved in the Salt-range collection, of which four were collected by myself in the section near Khura in thin-bedded limestones belonging to the upper region of the middle division of the Productus-limestone. One specimen I found in the mountains east of Katwáhi in the lower region of the middle division. Mr Wynne collected five specimens at Morah and one specimen in the Chittawán near Ghari, all of them also in the middle division of the Productus-limestone.

Remarks.—This species is rather similar to *Notothyris subvesicularis*, Dav., and *Not. warthi*, W., and might possibly be considered as a dwarfed variety of one of these species, but it would hardly be possible to take it for the young of one of those two forms. The reasons why I have not adopted either of those views are: firstly, that the species now under consideration does not exactly agree in external shape either with *Not. subvesicularis* or with *Not. warthi*. With the first of these forms it has the number of folds and the smallness of the beak in common, while it deviates from it by the strength and extension of the folds. By these latter characters, however, it agrees with *Not. warthi*, from which it differs again just by the characters in which it agrees with *Not. subvesicularis*. Thus the characters of those two species appear to be quite mixed in the present one.

But neither can *Not. minuta* be the young of the two above-mentioned species, as in *Not. warthi* the space for which the valves remain smooth is at least 8 mm. and in *Not. subvesicularis* it is still larger. Thus, if the present species was the young of one of those species, its valves, which never are longer than 9 to 10 mm., ought to be nearly quite smooth or only slightly undulating at their very margins. But just the contrary is the case.

I thus think I am perfectly justified in considering *Not. minuta* as a proper well defined species, which can by its small size alone be easily distinguished from the allied forms. The other characters by which it is distinguishable have already been indicated above.

7. *NOTOTHYRIS MULTIPLICATA*, Waagen, n. gen. et sp., Pl. XXVIII, figs. 12, 3.

The general outline of this species, which always exhibits very small dimensions, is broadly to elongately pentagonal, with not very strongly inflated valves, which are finely plicated, and a small beak.

The ventral valve is not very strongly but very regularly vaulted. The beak is small, not long, and well bent over, pierced at the apex or barely behind it, by a tolerably large round foramen. The deltidium seems to have been very small, but it cannot be well observed in any of the specimens at my disposal. The false area is not large, rather narrow and reaching down laterally to a very different extent in what we consider narrowly elongated or broadly rounded varieties. On the outside of the beak, just on its most prominent part a furrow commences, which extends over the valve down to where the plications begin, dividing the smooth part of the valve into two halves. The plications begin in this species at different heights in different individuals; whilst in some of them not quite half the length of this valve remains smooth; in others again the smooth part extends over more than two-thirds of the entire length of the valve. The plications are very numerous. There are generally 13 to 14 folds on this valve, of which three to four are on the frontal region. All these plications cause the margins of the valve to be finely serrated; the indentations on the frontal region are on a lower level than the remainder of the margin of the valve.

The dorsal valve is slightly flatter than the ventral one, but its curve is just as regular as that of the other valve. The valve remains smooth for a little more than from half to two-thirds of its entire length. The plications are 15 to 16 in number, which all appear as fine, sharp folds. Of these four to five are in the frontal region. They correspond to a broad, low, but distinct, depression of the valve, which causes the indentations of this part of the margin of the valve to project slightly over the remainder of the valve margin.

Of the internal characters of this species nothing could be ascertained, except that in a specimen with very transparent shell it appears as if a septum extended down on the ventral valve along the median furrow, from the beak to near the middle of the length of the valve; but nothing certain could be made out about it. The punctation of the shell substance is so fine that it is almost microscopic. Even with a very powerful lens it can only be seen under favourable circumstances. The punctation is not very close, but the punctures are very fine.

The measurements of three specimens, Nos. I and II from Musakheyli, and No. III from Moruh, are as follows:—

	I.	II	III.
Entire length of the shell	8.5 mm	7.5 mm	7.5 mm.
Length of the smaller valve	7.5 "	6.5 "	6.5 "
Entire breadth of the shell	8 "	6 "	5.5 "
" thickness " " "	5.5 "	5 "	4.5 "
Apical angle of the ventral valve	50°	75°	60°
" " " dorsal " " "	118°	117°	85°

Locality and geological position.—There are altogether three specimens of this species known to me, which all come from the middle division of the Productus limestone. Two of them were collected by Dr. Warth at Musakhryl, and one was found by myself near Morah.

Remarks.—This is a very strange little species, and it still remains doubtful if it is rightly attributed to the genus *Notothyris*. If it really possesses a septum in the ventral valve, as it appears to do in one of the specimens, its generic position is a very problematic one. As this circumstance could not, however, be positively determined, I have put the species into the genus *Notothyris*, because in its general outline it most nearly agrees with the shells belonging to that genus.

It is not difficult to distinguish this species from other species of *Notothyris* by the much finer and much more numerous folds it possesses. From the species of *Hemiptychina* which are similarly finely plicated, it can be distinguished by its front line, which is curved in an opposite direction.

9. *NOTOTHYRIS SIMPLEX*, Waagen, n. gen. et sp., Pl. XXVIII, figs. 9, 10, 11.

The general outline of this species is elongately oval or elongately pentagonal with a small beak and a W-shaped frontal line, and no marginal plications except the frontal ones.

The ventral valve is not strongly but very regularly vaulted. The beak is comparatively thin, strongly bent over and firmly adpressed to the apex of the smaller valve. It is pierced far behind its apex by a roundish foramen, from which an open canal descends to the apex, whereby the foramen, if not properly cleared, seems to possess a very elongated oval shape. In most specimens, however, the extreme apex of the beak is broken away, and then the foramen is very small and rounded. The deltidium could not be observed in any of the specimens. The false area is very differently developed in different specimens. In some it is broad and reaches far down the sides of the shell, in others it is very small and limited to the apical region. It is, however, never sharply defined from the remainder of the valve. The valve is smooth for by far the greater part of it, and only quite near the frontal margin the two strong folds appear. Otherwise, only striae of growth are observable; they are, however, never very conspicuous. The margin of the valve is always, and sometimes very considerably, cut out in the frontal region, so that the frontal part is on a much deeper level than the lateral parts.

The dorsal valve is nearly as strongly and regularly vaulted as the ventral one. This valve is perfectly smooth for by far the largest part of its extent, and only quite close to the frontal margin the three folds appear, of which the median one is the most conspicuous and strongly developed. The marginal part of the frontal region is generally very strongly depressed in this species, and is on a much lower

level than the lateral parts. The striae of growth are very numerous on this valve and often much more conspicuous than on the other one.

Of the internal characters of this species nothing could be ascertained. As far as could be made out, the substance of the shell seems to be very finely punctated, but it was not possible to be quite certain on this point, as the shell substance was too strongly crystalline to show its structure clearly.

The measurements of two specimens from Katta are as follows :—

Entire length of the shell	. . . . .	75 mm.	8 mm.
Length of the smaller valve	. . . . .	6 "	7 "
Entire breadth of the shell	. . . . .	6 "	6 "
" thickness " " "	. . . . .	55 "	45 "
Apical angle of the larger valve		70°	65°
" " " " smaller "		102°	110°

This species seems to grow to considerable size, but the largest fragment does not indicate a specimen of more than 10 mm. in length.

Locality and geological position.—There are altogether ten specimens of this species preserved in the Salt-range collection. Of these the greatest number (eight specimens) were found by myself at Katta in the lowest beds of the compact limestone forming the middle division of the Productus-limestone (bed No. 12 of the section in my note-book); one specimen I collected also myself at Nursingpohár in the identical beds which are there represented by black coaly limestones. The last specimen is somewhat doubtful. It was found by Mr. Wynne at Morah, but it does not exactly agree in shape with the other specimens, and, thus, it is not quite certain whether the species passes up also into the middle region of the middle division of the Productus-limestone, from which this specimen came.

Remarks.—This species is very easily distinguished from the other species of *Notothyris* by the absence of any lateral folds and the more strongly depressed frontal line. It is at the same time the geologically oldest species of *Notothyris* hitherto described. One might well think it a biological fact of some importance that the geologically oldest species should be the most simple one, as regards its sculpturing. It is, however, most difficult to trace the development of the remaining forms from this species. It seems at the first glance as if there were a certain connection between *Not. simplex*, W., *Not. minuta*, W., and *Not. warthi*, W., but by the side of the two latter species appear also all the others described before, and it is impossible to tell whether these should be traced from the same root, or whether they will have descended from other ancestors. As I now could not arrive at any definite conclusion in this matter, I have preferred to simply describe the species without giving any hints as to their probable developmental connection.

PLATE XXV.

PRODUCTUS-LIMESTONE.

- Figure 1. 2. *AVICULOPECTEN KATWAHIENSIS*, Waagen, n. sp., p. 318. 1. Specimen of a left valve, with partly preserved shell, from the upper division of the Productus-limestone of Katwahi: 1a, side view; 1b, front view. 2. Fragment of the shell of another specimen from the same beds and locality, enlarged.
3. *DIELASMA BIPLEX*, Waagen, n. sp., p. 340. Specimen from the middle division of the Productus-limestone of Vurcha: 3a, dorsal view; 3b, ventral view; 3c, side view; 3d, front view.
4. *DIELASMA BIPLEX*, Waagen, n. sp., p. 340. Specimen from the middle division of the Productus-limestone (Crinoidal-limestone) of Virgul. 4a, dorsal view; 4b, ventral view; 4c, side view; 4d, front view.
5. *DIELASMA BIPLEX*, Waagen, n. sp., p. 340. Silicified specimen from the middle division of the Productus-limestone of Murakheyl: 5a, dorsal view; 5b, ventral view; 5c, side view; 5d, front view.
6. *DIELASMA BREVIPLICATUM*, Waagen, n. sp., p. 356 (see also Pl. XXX, figs 11, 12). Specimen from the upper division of the Productus-limestone (*Cephalopoda*-bed) of Jabi: internal arrangement of the dorsal valve.
7. *DIELASMA ACUTANGULUM*, Waagen, n. sp., p. 353 (see also Pl. XXXVI, figs 1, 2). Specimen from the upper division of the Productus-limestone (*Cephalopoda*-bed) of Jabi: inside of the dorsal valve, showing the muscular impressions, the greater part of the crura and loop having been broken away.
8. *DIELASMA BREVIPLICATUM*, Waagen, n. sp., p. 356 (see also Pl. XXX, figs 11, 12). Specimen from the upper division of the Productus-limestone (*Cephalopoda*-bed) of Jabi: interior view of the dorsal and part of the ventral valve, to show the dental plates.
9. *DIELASMA NUMMULUS*, Waagen, n. sp., p. 341. Specimen from the middle division of the Productus-limestone (lowest beds) of Katta: 9a, dorsal view; 9b, side view; 9c, front view.
10. *DIELASMA ELONGATUM*, Schloth, sp., p. 342. Specimen from the middle division of the Productus-limestone (lowest beds) of Katta: 10a, dorsal view; 10b, side view; 10c, front view.
11. *DIELASMA TRUNCATUM*, Waagen, n. sp., p. 345. Specimen from the lower division of the Productus-limestone of Amb: 11a, dorsal view; 11b, ventral view; 11c, side view; 11d, front view.
12. *DIELASMA MINOR*, Waagen, n. sp., p. 346. Specimen from the lower Productus-limestone of Amb: 12a, dorsal view; 12b, side view; 12c, front view.
13. *DIELASMA TRUNCATUM*, Waagen, n. sp., p. 345. Young specimen from the lower Productus-limestone of Amb: 13a, dorsal view; 13b, side view; 13c, front view.

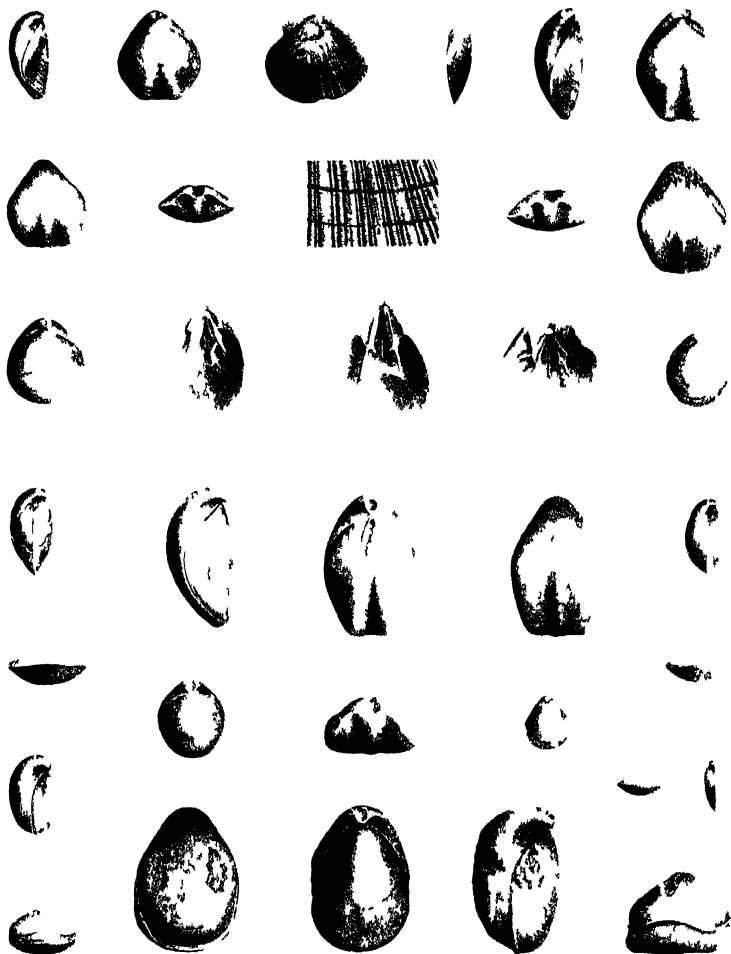


PLATE XXVI.
PRODUCTUS-LIMESTONE.

- Figure 1. *DIELASMA ACUTANGULUM*, Waagen, n. sp., p. 353. Specimen with partly preserved shell from the upper Productus-limestone (*Cephalopoda*-bed) of Chidru. 1a, dorsal view; 1b, side view; 1c, front view.
2. *DIELASMA ACUTANGULUM*, Waagen, n. sp., p. 353. Silicified specimen from the upper Productus-limestone (*Cephalopoda*-bed) of Jabi. 2a, dorsal view; 2b, side view; 2c, front view.
3. *DIELASMA PROBLEMATICUM*, (Dav.) Waagen, n. sp., p. 351. Specimen from the middle Productus-limestone of Morah. 3a, dorsal view; 3b, side view; 3c, front view.
4. *DIELASMA PROBLEMATICUM*, (Dav.) Waagen, n. sp., p. 351. A ventral valve only, from the middle Productus-limestone of Morah: 4a, ventral view; 4b, side view; 4c, front view.
5. *DIELASMA ITAITUBENSE*, Derby, sp., p. 348. Specimen from the lowest beds of the middle Productus-limestone of Nursingpahar: 5a, dorsal view; 5b, ventral view; 5c, side view; 5d, front view.
6. *HEMIPTYCHINA HIMALAYENSIS*, (Dav.) sp., p. 368. Silicified specimen from the middle Productus-limestone of Swas: 6a, dorsal view; 6b, ventral view; 6c, side view; 6d, front view.
7. *HEMIPTYCHINA HIMALAYENSIS*, (Dav.) sp., p. 368. Silicified specimen from the middle Productus-limestone of Musakhyl. 7a, dorsal view; 7b, ventral view; 7c, side view; 7d, front view.
8. *HEMIPTYCHINA HIMALAYENSIS*, (Dav.) sp., p. 368. Calcareous specimen from the upper Productus-limestone of Khund Ghat: 8a, dorsal view; 8b, side view; 8c, front view.
- 9, 10. *HEMIPTYCHINA HIMALAYENSIS*, (Dav.) sp., p. 368. Internal views of two specimens from the middle Productus-limestone of Musakhyl, both enlarged.

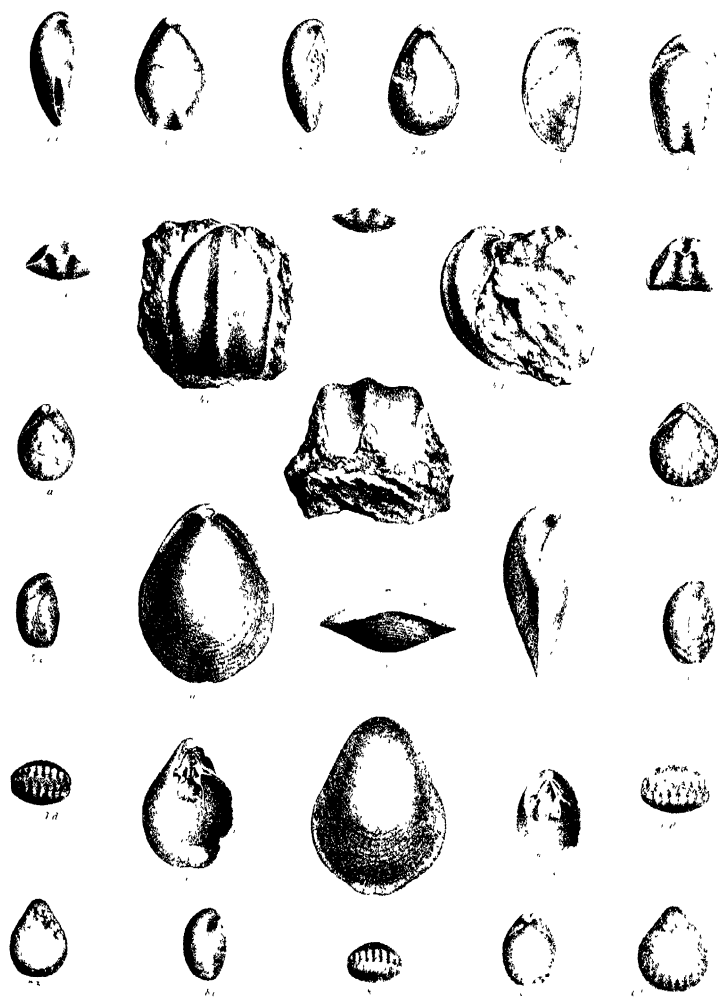


PLATE XXVII.

PRODUCTUS-LIMESTONE.

- Figures 1, 2, 3 **HEMIPTYCHINA SUBLEVIS**, Waagen, n. sp., p. 364. Three specimens from the lower Productus-limestone (*Chonetes*-bed) of Amb: 1a, dorsal view; 1b, ventral view; 1c, side view; 1d, front view; 2a, dorsal view; 2b, ventral view; 2c, side view; 2d, front view; 3a, dorsal view; 3b, ventral view; 3c, side view; 3d, front view.
4. **HEMIPTYCHINA SPARSIPPLICATA**, Waagen, n. gen. et sp., p. 366. Silicified specimens from the middle Productus-limestone of Swás: 4a, dorsal view; 4b, ventral view; 4c, side view; 4d, front view.
- 5, 6. **HEMIPTYCHINA SPARSIPPLICATA**, Waagen, n. gen. et sp., p. 366. Two specimens from the lowest beds of the middle Productus-limestone of Katta: 5a, dorsal view; 5b, ventral view; 5c, side view; 5d, front view; 6a, dorsal view; 6b, side view; 6c, front view.
7. **HEMIPTYCHINA INFLATA**, Waagen, n. gen. et sp., p. 372. Specimen from the base of the upper Productus-limestone west of Khura: 7a, dorsal view; 7b, ventral view; 7c, side view; 7d, dorsal view.
- 8, 9. **HEMIPTYCHINA INFLATA**, Waagen, n. gen. et sp., p. 372. Two specimens from the middle Productus-limestone of Morah: 8a, dorsal view; 8b, ventral view; 8c, side view; 8d, front view; 9a, dorsal view; 9b, side view; 9c, front view.
10. **DIELASMINA FLICATA**, Waagen, n. gen. et sp., p. 360. Specimens from the topbeds of the middle Productus-limestone of Khura: 10a, dorsal view; 10b, ventral view; 10c, side view; 10d, front view.
11. **HEMIPTYCHINA CREBRIPPLICATA**, Waagen, n. gen. et sp., p. 374. Specimens from the middle Productus-limestone of Morah: 11a, dorsal view; 11b, ventral view; 11c, side view; 11d, front view.



PLATE XXVIII.
PRODUCTUS-LIMESTONE.

- Figure 1. *NOTOTHYRIS WARTHI*, Waagen, n. gen. et sp., p. 382. Specimen from the upper Productus-limestone (*Cephalopoda*-bed with *Cyclolobus oldhami*) of Jabi: 1a, dorsal view, natural size; 1b, dorsal view; 1c, ventral view; 1d, side view; 1e, front view; the latter four figures enlarged.
2. *NOTOTHYRIS INFLATA*, Waagen, n. gen. et sp., p. 384. Silicified specimen from the middle Productus-limestone of Musakhey: 2a, dorsal view, natural size; 2b, dorsal view; 2c, ventral view; 2d, side view; 2e, front view; dorsal valve uppermost as in the other figures; the latter four figures enlarged.
3. *NOTOTHYRIS SUBVESICULARIS*, Dav. sp., p. 378. Silicified specimen from the middle Productus-limestone of Musakhey: 3a, dorsal view, natural size; 3b, dorsal view; 3c, side view; 3d, front view; the latter three figures enlarged.
4. *NOTOTHYRIS SUBVESICULARIS*, Dav. sp., p. 378. Internal view of a specimen from the middle Productus-limestone of Musakhey, enlarged.
5. *NOTOTHYRIS DJOULFENSIS*, Abich., sp., p. 379. Silicified specimen from the middle Productus-limestone of Swás: 5a, dorsal view, natural size; 5b, dorsal view; 5c, ventral view; 5d, side view; 5e, front view; the latter four figures enlarged.
6. *NOTOTHYRIS DJOULFENSIS*, Abich., sp., p. 379. Silicified specimen from the middle Productus-limestone of Musakhey: 6a, dorsal view, natural size; 6b, dorsal view; 6c, ventral view; 6d, side view; 6e, front view; the latter four figures enlarged.
7. *NOTOTHYRIS MINUTA*, Waagen, n. gen. et sp., p. 386. Specimen from the middle Productus-limestone of the Chittawan: 7a, dorsal view, natural size; 7b, dorsal view; 7c, ventral view; 7d, side view; 7e, front view; the four latter figures enlarged.
8. *NOTOTHYRIS MINUTA*, Waagen, n. gen. et sp., p. 386. Specimen from the middle Productus-limestone of Morah: 8a, dorsal view, natural size; 8b, dorsal view; 8c, ventral view; 8d, side view; 8e, front view; the latter four figures enlarged.
9. *NOTOTHYRIS SIMPLEX* (?), Waagen, n. gen. et sp., p. 389. Specimen from the middle Productus-limestone of Morah: 9a, dorsal view, natural size; 9b, dorsal view; 9c, side view; 9d, front view; the latter three figures enlarged.
- 10, 11. *NOTOTHYRIS SIMPLEX*, Waagen, n. gen. et sp., p. 389. Two specimens from the lowest beds of the middle Productus-limestone of Katta: 10a, dorsal view, natural size; 10b, dorsal view; 10c, ventral view; 10d, side view; 10e, front view; the latter four enlarged; 11a, dorsal view, natural size; 11b, dorsal view; 11c, side view; 11d, front view; the latter three enlarged.
- 12, 13. *NOTOTHYRIS MULTIPLICATA*, Waagen, n. gen. et sp., p. 388. Two silicified specimens from the middle Productus-limestone of Musakhey: 12a, dorsal view, natural size; 12b, dorsal view; 12c, ventral view; 12d, side view; 12e, front view; the latter four figures enlarged; 13a, dorsal view, natural size; 13b, dorsal view; 13c, ventral view; 13d, side view; 13e, front view; the latter four figures enlarged.
14. *DIELASMA GUTTULA*, Waagen, n. sp., p. 340. Specimen from the lowest beds of the middle Productus-limestone of Nursugpahar: 14a, dorsal view, natural size; 14b, dorsal view; 14c, side view; 14d, front view; the latter three figures enlarged.



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